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THE STRUGGLE FOR EXISTENCE IN SOCIOLOGY.

By J. COLLIER.

III.

THE POLITICAL STRUGGLE.

THE political struggle is a continuation of the ethnical struggle in a new sphere and under new forms. It is that struggle transferred from without to within the State, and extended to all departments of public life. The invaders are no longer foreigners; they are citizens of the new country, and they gradually blend themselves with almost all its ranks. The invasion no longer takes place on the frontiers; its waves mount to the halls of the legislature, flow through the courts of justice, and flood the chambers of administration. The nature of the struggle is unchanged—warfare is a mere incident of it, as it is of the ethnical struggle, and plays no smaller and no larger a part in it; the method is the same—slow displacement and supersession, not destruction or extermination; and the result is the same—the infusion of a new element into the institutions of a people, as into its ethnical composition. Even the instruments are not essentially altered; laws, judicial decisions, and administrative regulations continue, as they began, the work of fusion, and are only applied to new cases.

Thus the history of ancient Greece was the after-reflection of the struggle between the immigrant Hellenes and the indigenous Pelasgians, Carians, or what not. The long conflict between the patricians and the *plebs* of ancient Rome was a continuation of the strife between the immigrant Romans and the indigenous Latins; and its various incidents, such as the election of tribunes and of a plebeian consul, and the enactment of agrarian laws, were at bottom of the same character as the acts of aggression and resistance that constituted the invasion and the defence. Augustin Thierry's view, that the racial struggle between the Saxons and the Normans is the key to the subsequent political history of England. has not been accepted by historians in its entirety; yet if we will define "race" historically instead of ethnically, and consider the "Saxon race" as consisting of a mass of Teutons and Northmen (thus so far resembling the "Norman race"), on a compound basis of pre-Aryans and Celts (such as Ethnology shows to have existed in England), and all because of historical association and antagonism to the invaders, animated by similar dispositions, we shall find his view to be sociologically sound. It may then be used to explain our political history. The Tories were, and the Conservatives are, sometimes of Celtic or Turanian origin, but they have assumed, where they did not naturally have, the sentiments of a governing aristocratic race. The Whigs were, many of them, hereditary aristocrats, and the Radical and Socialist leaders have often been cultured patricians. None the less, both associate themselves with the characteristic feelings of their parties, and reflect their pristine antagonisms. The history of France has likewise been written by its greatest historians as that of a conflict between the various races that have successively occupied the soil. From the fifth century to the thirteenth it consisted in the gradual taking possession by the Germanic invaders of all the institutions of public and social life; from the thirteenth to the eighteenth, in the slow recovery by the indigenes of their lost ground; while the revolution was the uprising of the Celtic and possibly the Turanian masses.

THE DYNASTIC STRUGGLE.

The succession of dynasties resembles the immigration of new species. Like them, they slowly take possession of their new area. It will be more instructive to describe a single such case in some detail than to make vague general references that would leave no definite impression. The Carolingian dynasty sprang up by the side of the Merovingian, insensibly gathered strength, and at last supplanted it. A strong power was needed to keep in order the noisy and tumultuous crowd of nobles who surrounded the Frankish kings. They themselves elected a Mayor of the Palace, or Lord Chamberlain, as they had once elected their sovereigns. The mayor had at first no other office than to compose their disputes, and thus relieve the king of an irksome duty. As they naturally appointed one of themselves, and probably their strongest man, he soon became their head. Possessing so much authority, he naturally became chief minister of the sovereign. He soon made his position impregnable. In 613, after a struggle between the nobles and the dynasty, one mayor stipulated that he should never be deposed, and extracted from the king an oath to that effect. The office was next made hereditary in a particular family, that of Pepin, which had acquired wealth and consideration. King Dagobert died, leaving an infant son. The mayor became

regent or working king. The infant died, and in 656 the mayor made his own son king. It was too soon. The usurper was dispossessed by the vigorous sovereign of rival Neustria, who annexed the kingdom. The victor died the same year, also leaving only infant sons. The Austrasian grandees then deserted the race that had proved unable to defend itself, and made their mayor Duke of the Franks. It was the first titular step to sovereignty. Power at home leads to self-assertion abroad, and the Mayor of Austrasia attacked the Mayor of Neustria in 687 and defeated him in a great battle near Péronne.

Pepin brought back with him to Austrasia the king of the vanquished people, but the Merovingian dynasty was practically at an end. It indeed lived on for 65 years longer, but as the mere shadow of a royal race. Most of the kings died in youth or were old men before they were thirty. They were known as the "do-nothing kings." They retained the long hair and beard that were the emblems of kinghood. They sat on a throne and received ambassadors, to whom they recited dictated speeches. Once a year they appeared at the assemblies of the warriors. Generally they lived isolated on a farm, enjoying a pension (very irregularly paid, we are told) assigned them by the mayor. Of the two last surviving kings of the two kingdoms, one voluntarily entered, and the other was confined in, a monastery.

Meanwhile, the Mayor of Austrasia steadily gained ground. The family of Pepin grew in wealth and in sanctity, and Pepin gained consideration by his equity. He built up the executive authority and kept the nobles in subjection. His famous son, Charles Martel, defeated the Saracens at Poitiers, and saved northern Europe from invasion. Charles's son, Pepin the Little, conquered Burgundy and Aquitaine. He was then strong enough, with the approval and aid of the Pope, to proclaim himself king in 752. The struggle had lasted 150 years.

There was no lack of battle in its primary sense, as we perceive; assassinations of rival kings, queens, and mayors were not infrequent; but the gist of the dynastic struggle did not lie there. It lay in the steadfast advance of a new and still incorrupt ethnical variety and the slow recession of a race that died, not only of defeat, but of its own internal decline. Nor does the defeat of a dynasty necessarily involve its extinction. It may live on, driven into a remote or an inferior habitat. The Dukes of Gascony or Aquitaine and the Counts of Armagnac in the fifteenth century were the lineal descendants of King Charibert in the seventh.

The Ministerial Struggle.

The advent of a new dynastic variety commonly brings with it a new administrative variety, which is of the same race with it, like the Guises and like Sully, or which moulds it in its own image, as the doctrinaires of the French Restoration moulded the Orleans dynasty. But it may also spring up in sympathy with a new type of sovereign, and then we observe in both cases the rise of an original species. Charles V., well named the Sage (1364-80), was a new kind of monarch in France. Staying at home, while his luckless predecessors had gone out to the disastrous fields of Crécy, Poitiers, and Agincourt, he recovered by diplomacy as much territory as they had lost by war, and governed the country like a "citizen king." His Ministers, disdainfully called "small people" and "the marmosets" by the nobles, had risen up from the wealthy and instructed upper middle class, and they ousted, by mere choice of the King, the royal princes and feudal nobles who had long misgoverned France. Driven from office at his death by the re-entrant seigneurs, they were replaced in it eight years later by the new King, his son, and for four short years they ruled the country with wisdom. Unhappily, the insanity of the King again led to their exclusion, and another feudal reaction ensued. In all this there was no encounter between the two bodies of Ministers; no victory and no defeat. It is true that the chief Minister of the "marmosets" was assassinated, but by a noble in personal revenge. A change of moral climate, so to speak, a return of the glacial epoch, as it were, made the continued existence of the new men impossible.

The first Bourbon king of France inaugurated, or revived, the modern type of Minister in the great Sully. Henry's strong personality survived his assassination, and kept the Minister in office for a while, but a new political atmosphere soon made him obsolete. The Italian Queen-mother initiated a foreign policy, involving a Spanish alliance, with which the Protestant could have no sympathy. His colleagues, Villeroy, Sillery, and Jeannin, kept their ground during the first phase of the regency, and then they too had to go. The "grey-beards" were replaced by the "young people"—Barbin, Mangot, Brienne, and Richelieu. Again there was no battle. An Italian favourite, Concini, had confirmed the new direction given to the policy of France, and, from Protestant and German, had made it Catholic and Spanish. There was no conflict between the new Ministers and the old. As Gabriel Hanotaux has observed, it was "the pressure of interests and events" that bore the new Ministers to office. The change of environment killed the old species and favoured the survival of the new. When Richelieu subjugated his colleagues, and reigned alone, or in company with the formidable Father Joseph, it was because his bold and original genius had created a new environment once more, and made French policy swerve back into the channel that Henry had dug for it. The deposition of this Minister or that was a mere incident of the struggle.

The rise and fortunes of the Doctrinaire Party have been narrated in the delightful *Souvenirs* of Duke Victor de Broglie, the worthy son-in-law of Mme. de Staël, who might perhaps be named the ancestress and spiritual founder of the party. It inherited her brilliancy and her rectitude. Guizot was its brain; Camille Jordan its heart; de Serre its orator; Broglie its cross-fertiliser; Barante its historian; and Charles de Rémusat its philosopher. Planted before the Restoration, it sprang into prominence in 1818. In the beginning of that year, though numerically "almost imperceptible," it elected the President of the Chamber, and before the end of the year it placed in office a Ministry that was called the Doctrinaire Ministry, because "the party was the nerve and brain" of the Ministry, though only one of its members was a Minister. Not till after the Revolution of 1830 did it form a Ministry of its own, and that lasted for little more than two months, but it may be said to have moulded the French legislature in its own image. We need not further follow its fortunes. Nor need we take too seriously the military phraseology in which the party struggle is described by the Duke, who had lived through the wars of the Republic and the Empire. The doctrinaire party was "a headquarters staff without soldiers"; it "planted its flag" in certain positions; it was "vanquished" on certain grounds; a system or a law was "keenly attacked"; a bill was "combated," and "during the height of the combat . . ."; and so on. The phrases do not deceive us; we are familiar with them in our own histories and journals; and no one who has witnessed an oratorical tourney in the House of Commons, especially in the great days of Gladstone and Disraeli, will underrate the element of battle in Parliamentary debates. It is assuredly an essential part of the Ministerial struggle in free countries;

but it is a secondary part. The primary and real struggle in France consisted in the incessant effort to propagate the new ideas, revealed in the lectures of Guizot, Villemain and Cousin at the Sorbonne; in the pamphlets of Benjamin Constant and the articles of Armand Carrel; in the poetry of Lamartine and the prophecies of Lamennais; and in the salon of the beautiful and intellectual Duchess de Broglie. There, and in similar quarters, was waged the true battle. In the political remoulding of the middle class and the foundation of constitutional government lay the victory. In the hopeless obsolescence of the *ancien régime* lay the defeat.

FAMILIAR BRITISH WILD FLOWERS AND THEIR ALLIES.

By R. Lloyd Praeger, B.A.

VI.—ORCHIDS.*

Of all the orders of British plants, Ferns and Orchids are perhaps the two which are most attractive to lovers of plant-life, either native or exotic. And just as the splendid Adiantums and Cattleyas of foreign climes form one of the chief interests of the cultivator under glass, so to the British student of nature our more modest forms of Orchids and Ferns possess a special attraction. Orchids are in all ways a group of surpassing interest. This interest centres in the flowers, with their amazing range of form and colour, both of which features are connected with their remarkable structure in relation to cross-fertilization by insects. Though the British Orchid flowers are small in comparison with the gorgeous tropical forms, they nevertheless exhibit a variety of adaptation that may well hold the student's attention. In other directions, too, our Orchids invite study. From the point of view of geographical distribution, no British Natural Order offers a more varied field, nor problems of more profound importance in the study of plant-migration. Like the Heaths and Gentians sketched in my last article, the Orchids are a thoroughly *wild* group. Not a single member of the Order seeks the haunts of man. Towns and tilled ground know them not; only a few will flourish freely in cultivation, however we coax them. The meadows, heaths, woods and marshes are their stronghold; here, amid Meadowsweet and Heather, Gorse and Sedge, and in dark woods among beds of rich humus, they open their strange flowers, and disperse their curious powdery seed.

The British Orchids are all, like their foreign associates, herbaceous perennial plants; but while a large number of the exotic species are epiphytic in habit, perching on the damp branches of trees and climbers in steaming tropical forests, the British Orchids are all terrestrial. The majority live among the crowded herbage that peoples the meadows and copses. The root-system of most of these consists of a bundle of fleshy fibres. Each season one of the fibres produced swells into a tuber, which fills itself with food for next year's shoot as the previous year's tuber exhausts itself. The shoot which rises annually from the shortened root-stock produces a number of lanceolate or strap-shaped alternate leaves, and ends in a spike of flowers of various colour and form. A few, such as the Bird's-nest Orchis (*Neottia Nidus-avis*), which have their home in dark woods, are saprophytes. They draw the whole of the nourishment they require from decaying vegetable matter; green leaves being thus rendered unnecessary, are absent; and the plants are of dull hues of brown and yellow. One of our British Orchids, the Marsh Helleborine (*Epipactis palustris*), has an underground root-stock which creeps extensively—half a foot per year, or more—producing each season a leafy flowering-shoot, and a bunch of root-fibres for its nutrition; and the Creeping Lady's-tresses (*Goodyera repens*) has a similar creeping habit. The saprophytic species have all curious roots and root-stocks. In the Bird's-nest Orchis the root-stock is shortly creeping, surrounded by a dense mass of brown fleshy root-fibres, which bear only a very distant resemblance to a bird's nest. In the Leafless Epipogum (*E. aphyllum*), and the Coral-root (*Corallorrhiza innata*), two very rare species, the root-stock is composed of a branching fleshy mass, resembling coral. Three of the British Orchids are inhabitants of bogs—the very rare *Spiranthes æstivalis*, the Fen Orchis (*Liparis Loeselii*), now almost or quite extinct owing to the draining of the fens, and the tiny Bog Orchis (*Malaxis paludosa*), a greenish-yellow plant a few inches high, growing in cushions of Sphagnum. Both of the last-named species produce each year a bulb-like bud by the side of the old one; and *Malaxis* is in addition proliferous, bearing a bead-like fringe of tiny bulbils round the edges of its short leaves.

Let us next examine the structure of an Orchid flower—any of our common meadow species of *Orchis* or *Habenaria* will suffice. The ovary is inferior and drawn out, so that it looks like the stalk of the flower, which is in reality

Fig. 1. — Single flower of Sweet-scented Orchis (*Habenaria conopsea*). 1, Axis of the flower-spike; 2, bract which subtends each flower; 3, the twisted ovary; 4, the upper sepal; 5, 5, the lateral sepals or wings; 6, 6, the lateral petals; 7, the lower petal or labellum; 8, the spur formed by the backward prolongation of the labellum; 9, the two anther-lobes; 10, the stigmatic surface.

sessile. The calyx, consisting of three sepals, as in many Monocotyledons, is coloured and corolla-like. The corolla consists of three petals, also coloured, and alternating with the sepals. As the flower expands, the ovary twists through half a turn, thus inverting the flower, and making the lowest part the uppermost. Thus inverted, the flower exhibits a large upper sepal, which arches over the blossom, forming a kind of hood; the remaining two sepals, called the wings, spreading horizontally on either side. Of the three petals, two comparatively small ones join the upper sepals in providing a roof for the essential organs; the third (the *labellum*), much expanded and brilliantly coloured, spreads downward; it is continued backwards into a long hollow spur, in which honey is secreted. The ovary is prolonged forwards into the inner part of the roof of the flower, where it forms a fleshy projecting mass (the *column*), in which the essential organs are embedded. The single stamen—single in all British Orchids except the Lady's-slipper (*Cypripedium*)—consists of a two-lobed anther embedded in the column. Each lobe of the anther

* For the use of the figures which illustrate this article, the writer is indebted to Messrs. C. Griffin & Co., Limited. They are taken from his "Open-air Studies in Botany."

splits lengthwise, revealing a number of pollen-grains held together in a club-shaped mass by a number of delicate threads. Each of these pollen-masses is continued downwards in a delicate stalk which terminates in a sticky pad overhanging the entrance to the honey-tube. The pistil is represented by a sticky flat surface, corresponding to two stigmas, placed a little below the stamen; the third stigma being modified into a knob of varied shape (the *rostellum*), between the anther and the stigmatic surface. This remarkable flower-structure is especially adapted for cross-pollination by insects, self-pollination being practically impossible; and, furthermore, only a very few chosen insects can reach the honey, or fertilize the plant. We can imitate the visit of a bee, which is one of the favoured agents, by gently inserting into a newly-opened *Orchis* flower a sharpened lead pencil, and we will understand how this complicated mechanism works. The hypothetical bee's head, pushed into the entrance of the flower (as the insect hangs on the convenient landing-stage formed by the labellum), in order that its proboscis may reach the

FIG. 2.—Pollen-mass of Orchis, withdrawn by insertion of a pencil into the flower. *a*, Position when withdrawn. *b*, Position after exposure to the air.

honey stored at the end of the long spur, comes in contact with the sticky knobs which terminate the pollen-masses. One or both attaches itself to our pencil, which draws it out of its sheath as we withdraw it. And now rapid and remarkable changes occur. In about half-a-minute the attaching cement sets hard and firmly fastens the mass to its newly-found support. At the same time, owing to the unequal contraction of the stem of the pollen-mass, caused by drying, its axis becomes bent, and it rapidly bends through a right-angle, so that the bundle of pollen no longer stands upright on the pencil, but points forward. What will happen when our hypothetical bee visits another flower, we can see. When the bee's head is inserted into the second flower, the pollen which it carries will, owing to the deflection of its stalk, come in contact, not with the corresponding anther, but with the sticky stigmatic surface which lies immediately below: and thus cross-fertilization is effected. Furthermore, only a little of the pollen will adhere to this stigma, and as the bee visits further flowers, the pollen will be widely spread among the various blossoms, the bundle attached to the bee's head becoming smaller and smaller till at length only the flexible stalk remains. The above description will apply to most of our commoner Orchids, though even among the British species a considerable range of form is found. In *Epipogum*, *Liparis*, and *Malaxis* the flower is not inverted, the labellum being uppermost: but in *Malaxis* this is caused, curiously enough, not by the ovary being untwisted, but by its being twisted twice as much as usual, the flower-bud making a complete revolution. Thus, in the curious *Epipogum* we find the coloured labellum forming the roof of the flower, the yellowish lanceolate sepals the landing-stage; the anther and stigmas are placed on the floor, instead of the roof of the tube, the pollen adhering to the under-side of the visiting insect. In the Bee Orchis (*Ophrys apifera*), again, the anther-lobes are not embedded, but dangle freely in front of the stigmatic surface, against which they are blown or pushed, this plant being apparently always self-fertilized, in spite of its elaborate structure and brilliant colour, which point to entomophilous habits. The Tway-blade (*Listera*) and Bird's-nest Orchis (*Neottia*) are, as regards their flowers, remarkable in possessing an exceedingly sensitive rostellum, which, on the lightest touch, instantly ejects a drop of gummy fluid, which sets hard in a few seconds, firmly securing the pollen-mass to the object—presumably the head of an insect—which caused the disturbance.

The British Orchids are over forty in number—forty-four according to the *London Catalogue*, which includes one or two which are often treated as varieties. *Orchis* is the largest genus, numbering twelve species; and with the allied genus *Habenaria*, constitutes the bulk of the Orchid flora of our meadows. These are all plants with roundish or palmated tubers, succulent stems and leaves, and spikes of purple, red, pink, greenish or white blossoms, many delicately fragrant. The Early Purple Orchis (*O. mascula*), and the Green-winged (*O. Morio*), the latter

FIG. 3.—Flower of Early Purple Orchis (*O. mascula*). 1, Side view; 2, front view. Natural size.

not found in Scotland, appear first, and brighten our spring pastures. Following them comes a rush of meadow Orchids in June—the Spotted (*O. maculata*), Broad-leaved (*O. latifolia* and *O. incarnata*), Pyramidal (*O. pyramidalis*) very rare in Scotland, Butterfly (*Habenaria chloroleuca*

FIG. 4.—Flower of Spotted Orchis (*O. maculata*). × 2.

FIG. 5.—Flower of Butterfly Orchis (*Habenaria chloroleuca*). Natural size.

and *H. bifolia*), Sweet-scented (*H. conopsea*), and the little Frog Orchis (*H. viridis*), appear in profusion, forming one of the most charming sections of our native wild flowers. The remaining species of these two genera are not so common. The dark little *Orchis ustulata* is frequent on limestone or chalk in England, but does not extend to Scotland or Ireland. The Lizard Orchis (*O. hircina*), a fine plant with a remarkable long curly labellum, is an exceedingly rare plant of the chalk. *O. purpurea*, also a comparatively large plant, is almost confined to Kent. *O. militaris* has a very limited range in Herts, Berks, Oxford and Bucks. *O. simia* seems to be confined to Oxford, Berks, and Kent. The last three are all chalk plants, and have been much confused. The rarer species of Habenaria are *H. albida*, a plant which loves pastures on the fringe of the mountains, and has a wide distribution, and the rare little *H. intacta*, or Close-flowered Orchis (=*Neotinea intacta*), growing on limestone pastures in the West of Ireland, and to which we shall refer again

later. Our meadows may also yield one or other species of the remarkable genus *Ophrys*, in which the mimicking of animal forms by the flowers is carried to a truly wonderful degree. The beautiful Bee Orchis is the most

FIG. 6.—Flowers of Bee Orchis (*Ophrys apifera*). Natural size.

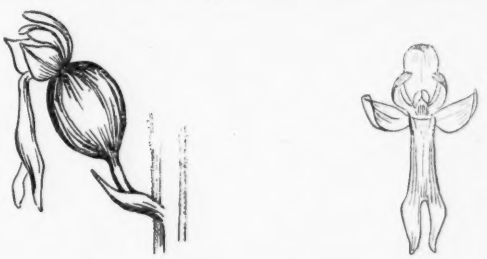
frequent of these, with showy pink sepals, and velvety recurved labellum, looking marvellously like a bee's body. It ranges over England and the greater part of Ireland, and, like all the members of its genus, loves a limy soil. The Fly Orchis (*O muscifera*), which has a similar distribution, is a smaller plant, with dark red flowers which mimic the appearance of a fly—head, body, wings and legs complete. *O. Arachnites* and *O. aranifera*, the Early and Late Spider Orchis, are local English chalk plants. Allied to the foregoing are the Man Orchis (*Aceras anthropophora*), a little yellowish Orchid with a long lobed labellum with an outline resembling the human body, with its arms and legs; and the Musk Orchis (*Herminium Monorchis*), a small green plant widely spread over the East of England.

Epipactis and *Cephalanthera*, the Helleborines, are rather tall plants with leafy stems and lax spikes of flowers. In root, stem, and leaf they are less succulent than the genera we have been considering. In the structure of the flower they are simpler. The root-stocks are tufted or creeping, and devoid of tubers. They are chiefly plants of woods and rough ground. The best known is *Epipactis latifolia*, Broad-leaved Helleborine, with a stem a couple of feet high, clothed with broad pointed leaves, and terminating in a long spike of greenish flowers mottled with purple and brown. The Marsh Helleborine (*E. palustris*) is a shorter plant with fewer leaves and flowers; the flowers are very beautiful, being large and white, or tinged with pink, with a large lip contracted above, broadened and delicately fringed below. It inhabits wet ground, and has already been mentioned as creeping extensively. *E. atro-rubens* is a very local plant which haunts the bare limestone pavements of England and Ireland; its blossoms are dark red in colour. *Cephalanthera* includes three British species, all handsome tallish plants with lanceolate leaves. *C. grandiflora* and *C. ensifolia* have white blossoms composed of five almost equal segments and a short labellum tinged with yellow; the former has its headquarters in the south of England, the latter is widely but locally distributed in our islands. The Red Helleborine (*C. rubra*) is a very rare chalk plant, with purplish-red blossoms.

Spiranthes is an interesting genus, easily recognised by the spiral arrangement of the flowers. *S. autumnalis* (Autumnal Lady's-tresses) is a small plant flowering in August, and widely spread in dry pastures on a limy soil in England and Ireland. The flower-stem rises several inches from a little tuft of leaves, and bears a spike of small deliciously fragrant white blossoms, arranged in a single spiral row. The Summer Lady's-tresses (*S. æstivalis*) is a taller plant, with minute whitish blossoms arranged as in the last. It is an extremely rare bog plant, which has been found in Hants and Worcester. Finally we have *S. Romanzoffiana*, the most famous of all British Orchids, of which, till lately, the only known European station was in Co. Cork; it has lately been found in several spots in the north of Ireland, in the valley of the River Bann. It is larger than either of the preceding, with a spike of exquisitely fragrant greenish-white flowers arranged in three spiral rows. *Goodyera repens*, the Creeping Lady's-tresses, is almost the only British Orchid which has a northern distribution. It is frequent in the north of Scotland, coming as far south as Cumberland. It is an inhabitant of fir-woods, and its root-stock creeps extensively amid the decaying fir-needles which cover the ground. The slender flower-stem rises from a cluster of rather broad short leaves, and bears a *Spiranthes*-like lax twisted spike of small white flowers.

FIG. 7.—Autumnal Lady's-tresses (*Spiranthes autumnalis*). Two-thirds natural size.

Of *Listera*, or Tway-blade, we have two species. *L. ovata* is a common plant, growing with the familiar species of Orchis and Habenaria in meadows, etc. It is easily recognised by its nearly opposite pair of large egg-shaped leaves, and long narrow spike of small greenish-



1. 2.

FIG. 8.—Flower of Tway-blade (*Listera ovata*). 1, Side view; 2, front view. × 2.

yellow flowers. *L. cordata*, the Mountain Tway-blade, is a delicate tiny plant which has its home among the moss under deep Heather on mountains. Its leaves are heart-shaped, its blossoms extremely small. The root-system of *Listera* consists of a bundle of fleshy root-fibres surrounding a bud, and devoid of tubers.

The remaining genera of British Orchids, six in number, are represented by only one species each. Most of them have already been mentioned in one or other connection.

Of the three leafless saprophytic kinds, the Bird's-nest Orchis, *Neottia Nidus-avis*, is easily known by the pale brown colour of its stem and flower-spike, resembling the dead beech-leaves among which it loves to grow. It is a comparatively large plant, attaining a foot or more in height. In general appearance it is very like the parasitic Broom-rapes (*Orobanche*), but the flower has all the characteristic features of the Orchid. The Coral-root (*Corallorrhiza innata*) sends up from its curious branching root-stock a slender greenish stem devoid of leaves (though bearing a few sheaths) which terminates in a lax spike of small whitish flowers. This is a rare Scottish plant, growing in boggy woods. The third saprophyte, *Epipogum aphyllum*, is a pale yellow leafless plant with flowers variegated with pink. In Great Britain its inclusion in the flora rests on a single station discovered many years ago in Herefordshire, where it has not been seen since.

Of the three remaining Orchids, *Liparis Loeselii*, the Fen Orchis, now nearly extinct, has a pair of comparatively large basal leaves, and a spike of a few small whitish flowers. Next we have the tiny Bog Orchis (*Malaxis paludosa*) already referred to, a little fleshy yellowish plant, found in clumps of Sphagnum on bogs here and there throughout the British Islands. Lastly, a very different plant claims our attention—the beautiful Lady's-slipper, *Cypripedium Calceolus*. This plant differs materially in structure from all other British Orchids; it has two stamens instead of one, and the whole flower is constructed on a different model, the labellum being very large and pouch-shaped. In our only British species the large and beautiful flower is maroon, with a yellow labellum. It is a very rare North of England plant, now probably extinct.

Reviewing generally the distribution of our Orchids, we find that they are on the whole a lowland lime-loving group. Only a little over a dozen species out of over forty have a thoroughly wide distribution; most of the others have their headquarters in the south and east of England, where the chalk prevails, whence some, such as the Pyramidal Orchis, Bee Orchis, and Autumnal Lady's-tresses, spread outwards for a considerable distance; others, like the Red Helleborine and *Orchis simia* and *militaris*, being confined to one or two stations within that area. A few (*Liparis*, *Spiranthes æstivalis*, and *Malaxis*) are bog plants, all but the last being of very restricted English range. *Habenaria albida* and *Listera cordata* haunt the uplands. Two species, the Creeping Lady's-tresses and the Coral-root, are northern, and with us confined to Scotland. The lovely Lady's-slipper has, or had, its home in the North of England.

Lastly, we have two particularly interesting outlying species, found in the British area in Ireland alone—*Habenaria intacta* and *Spiranthes Romanzoffiana*. These at once arrest the attention of the student of geographical botany as representing the two extremes of our flora—the furthest limits from which the elements which compose our present vegetation have been drawn. *H. intacta* is a characteristic Mediterranean species, inhabiting Spain and Portugal, southern France, Italy, Dalmatia, and Greece. A wide stretch of sea and land separates it in its Irish home from its next present habitat. It is probably a very early inhabitant of Ireland, which in old days crept northward along a former European shore-line which has now long disappeared below the waves. Here, on the warm limestones of the almost frostless west of Ireland, it still survives in quantity. The other Irish Orchid, *Spiranthes Romanzoffiana*, has a very different origin, but a similar tale to tell. This is a sub-Arctic plant, with its headquarters in Canada and the northern United States. It has crept across Behring Sea into Kamtschatka, but elsewhere in the Old World it is known only in Ireland. To account for its presence here, we must assume that land formerly occupied part of the area now covered by the North Atlantic Ocean. Perhaps by way of Greenland and Iceland the plant may have migrated eastward; possibly the lonely peak of Rockall, or the Porcupine Bank, represents the wreck of its former home. But here, cut off by thousands of miles of sea from its nearest settlement, it grows still, a living monument of the changes that earth has seen even since our present flora began to colonize the land.

CONSIDERATIONS ON THE PLANET MARS.

By E. M. ANTONIADI, F.R.A.S.

IT is now more than a quarter of a century since Schiaparelli called attention to the "canal" system of Mars, and, during this time, thought has been active in framing theories to account for the new facts revealed by observation. So long as the term "canal" was agnostically applied to streaks which united to one another the so-called "seas" of the planet, there could be scarcely any improvement on its choice, and no objection to its use. But when the Milan observer spoke of the "robust dikes" and "inundations" of these "canals," the care of opening whose locks would have been committed to the Martian Secretary of State for Agriculture himself, a distinct shade was cast on the seriousness of the term in question.

Two years had not elapsed after the discovery of the "canals" before the late Mr. Green urged the objection that some of them were nothing else than the edges of faint half-tones; and that, in such markings, it was difficult to recognise the earthly attributes of water channels. But this far-reaching remark of the gifted English observer was soon cast into oblivion before the apparently weightier evidence of Schiaparelli's observations, which, for many years, seemed to carry everything before them. It was gradually realised, however, that to assume the full objective reality of the Milan results implied such a startling state of things on our ruddy neighbour, that it was no longer safe to follow Schiaparelli's *interpretations* to the letter. But no one ever thought of challenging the veracity of the various telescopic *impressions* disclosed by the laborious watches of the great Italian astronomer. Slowly and patiently those results have been exhaustively confirmed by the ablest followers of Schiaparelli, and are now permanently acquired to science.

We are indebted to the abnormal peculiarities of the "canals" for that seasonable reaction. Their sudden shifts of position, leaps, disappearances, reappearances, intensifications and duplications, marked out the "canals" as rather the inconstant vagaries of physiological phenomena than as the permanent features of a cooling world. All Martian energy must necessarily have its source in the sun, since the presence of polar snow-caps shows us the surface of the planet to derive so small a quantity of heat from the interior as never to enable it to attain, unassisted, the freezing point of water, or perhaps even of carbon dioxide. The elegant cosmogonical speculations as to the youth of Mars are thus completely outweighed by this more credible observational testimony.

The question of the objectivity, or of the subjectivity of the "canals" has frequently been examined, and often decided one way or the other. A careless observer would, in fact, deem it more reasonable to consider the "canals" either as wholly imaginary, or as wholly real, than as a mixture of both reality and illusion. He could speciously argue that there must be one single cause for the canal impression; and that, by tracing the latter to a variety of sources, our reasoning becomes unphilosophical, and betrays

our inability to deal with this obscure question. But, as ably pointed out by Mr. Maunder in the exposition in this number of KNOWLEDGE of his most valuable experiments, we have now reached a stage where we are certain of the existence of some dusky streaks, and justly suspicious of the reality of others. The "canal" named Cerberus, for instance, is often as dark and definite as a "sea"; its objectivity is thus above question, unless, indeed, we come to doubt the very existence of large dusky areas on Mars. Several other "canals"—say one-third of the whole number—have also more or less strong claims to reality; although some of them are only the boundaries of the half-tones to which Mr. Green has called attention, while others, in accordance with Mr. Maunder's theory, are an integration of visible minute, or still smaller, and invisible, details. The philosophical importance of Mr. Maunder's experiments lies in the demonstration that, in order to appear furrowed with "canals," the Martian deserts require only an irregular distribution of any kind of minute grey markings. We need, therefore, no longer believe that "a Martian would be fifty-fold more efficient than man, whether in digging canals, or in other bodily occupation";* and thus, for the suspicious achievements of the hardy canal digger, modern science has fitly substituted the more rational interpretation of physiological principles.

During the last opposition of Mars, in the early spring of 1903, the writer was enabled to confirm part of Mr. Maunder's theory for two "canals," the Oxus and the Casius, both of which were seen composed of a congeries of small dark spots, at the limit of visibility (*see* the annexed Plate, drawings of April 6th, $\omega = 341°$, and April 11th, $\omega = 260°$). These observations were made with an 8½-inch reflector by Calver, magnifying 292 and 408 diameters, the excellence of whose mirror rendered possible an abnormally sharp view of the "canal" Oxus. Instead of uniting, as usual, Margaritifer Sinus to Arethusa Lacus,† the Oxus ran, as in 1886, into Ismenius Lacus, being very narrow and black towards the south, then swelling out into a lake-like patch, and finally fading off into Ismenius Lacus. Equally objective, though less sharp, were the so-called "canals" Cerberus, Cyclops, Hades, Eurotas, Nilokeras, Nilosyrtis, Pierius, and Protonilus; while a weird black hook, curving out of Ismenius Lacus in a southerly direction, also gave an overwhelming impression of reality.

Having thus admitted the partial objectivity of the Schiaparellian "canals," though carefully avoiding to consider them as artificial watercourses, we must now give our reasons for refusing to accept them in their entirety. Doubt arises here from the fact that the Milan observer has seen subjective "canals" on Mercury also; and that, as shown by Mr. Lowell's planetary observations, and by Mr. B. W. Lane's invaluable experiments,‡ the "canaliform illusion" is a normal physiological phenomenon. If, therefore, non-existent "canals," as harsh as the markings on the moon, affect the discs of other planets, they are also certain to attack the appearance of Mars; and there must be a limit beyond which the phenomena of the real Martian "canals" are continued, or imitated, by the illusions of prolonged eye-strain, if not of fancy.

If we inquire into the relevancy of Mr. Green's interpretation for some "canals," we shall find that it accounts for one-half of the linear markings. Its principle may be illustrated by a representative example. While in 1883-1884 Schiaparelli was seeing the region called Utopia as a yellow triangular area, limited by black "canals" (Fig. 1), Mr. E. B. Knobel, F.R.A.S., one of our ablest authorities on the planet, was seeing the same region intensely shaded (Fig. 2).

We are naturally curious to know which of these two

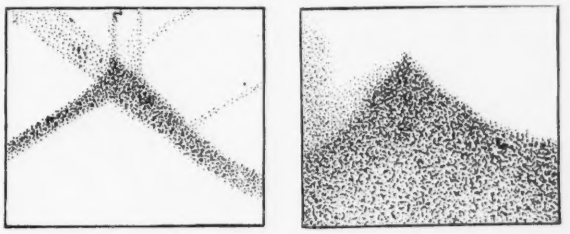


FIG. 1. FIG. 2.

The Region Utopia on Mars, as seen in 1883–1884 by Prof. Schiaparelli and Mr. Knobel.

Illustrating the Instrumentality of Contrast in reducing a Dusky Shading into a Canal-girt Bright Area.

appearances expresses more truthfully the actual configuration of this part of the Martian surface. A little consideration will render it evident that, since the dark area seen by Mr. Knobel is not resolved into separate dusky markings by Schiaparelli, the Englishman's representation is more trustworthy than the Italian's—a result which implies that the eye of Schiaparelli is affected by a strong personal equation, or a peculiar physiological bias, which strains it to decompose dark spots into more or less bright polygons, limited by black "canals."

But contrast does not confine its action to the intensification of the boundaries of faint half-tones. Enjoying a much greater generality, it affects the appearance of all definite markings of the surface. A mere glance thrown

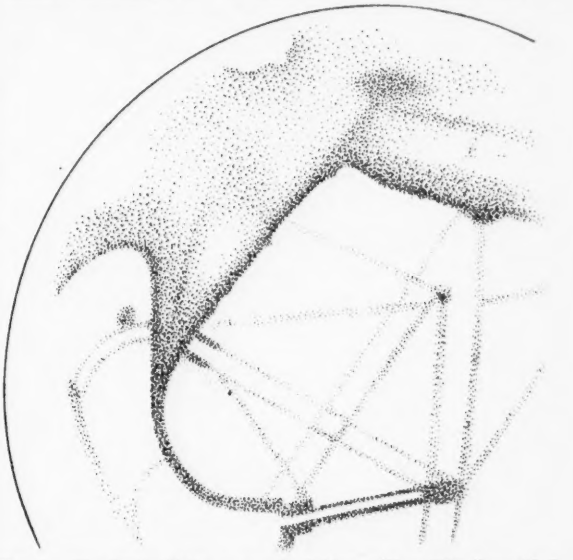


FIG. 3.—The Syrtis Major, as seen by Schiaparelli on 1888, June 4th.*

Illustrating the Instrumentality of Contrast in breaking up the Intensity of a very Dark Area into a Pale Shading limited by Black "Canals."

on Fig. 3 will suffice to corroborate this assertion. Here we have to deal with an observation, by Schiaparelli, of

* Lowell, *Mars*, p. 205.

† For the identification of the markings see the Chart of Mars in KNOWLEDGE for November, 1902, p. 252.

‡ KNOWLEDGE for November, 1902, pp. 250-251.

* *Memoria Sesta*, Pl. IV., Fig. 10.

the Hour-Glass Sea—always the most conspicuous, and often the darkest, area on Mars—in which the heavy shading of that great "sea" is shown reduced to a pale triangle, bound by "very black" lines.* Were this an isolated case it might have been argued, with some glimmer of probability, that the limiting "canals" were real objects. But the appearance shown on Fig. 3 is only a clearer representation than usual of a constantly recurring phenomenon, since the darkening of the Martian "seas" near their "shores" has been invariably one of the leading features of Schiaparelli's delineations.

Such a systematic intensification of the margins of the dark spots, implying as it does the incongruity, even if it be the only one of nomenclature, that the seas of Mars are themselves bounded by canals, cannot correspond at all to objective markings of the surface. That the intensity of the grey spots is far from being uniform no one will deny; but to maintain that real differences of albedo so manage their distribution as to imitate exactly the phenomena of contrast, is to deny the weight of philosophical probabilities which have all the force of practical certainties.

These conclusions may now be checked by deduction. If due to contrast, the marginal "canal" ought to be sharply bounded on the outside, but to shade off more gradually into the darker expanse beyond; and it is noteworthy that this corollary is in exact agreement with Signor Schiaparelli's experience, since, speaking of the "canal" limiting Syrtis Major on the following side, he says that "along Aeria, it was better defined to the right than to the left,"† or better on the bright side than on the dark one.

The apparent intensification of all indentations of the Martian "coasts" is another inference from our proposition, and is equally in harmony with experience. Let M in the annexed Fig. 4 be a grey area, whose border, R S, is exalted by contrast into the familiar black "canal"

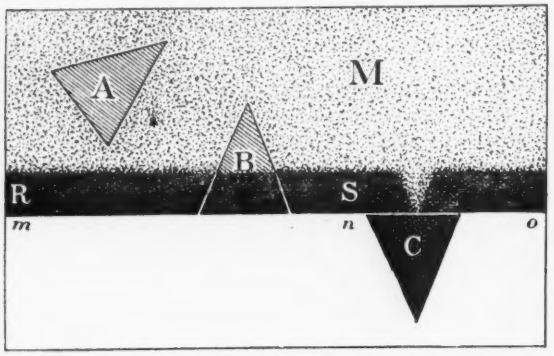


FIG. 4.—Illustrating the Effect of Contrast in enhancing the Darkness of the Indentations of the Martian Coasts.

appearance; and let us now consider the influence of position on the apparent darkness of a dusky triangle, having the same albedo as the dark spot M. As long as our triangle remains outside the illusive "canal" snare, as at A, it is, of course, indistinguishable from the general duskiness; but if its base coincide with the limits *m n* of the grey spot, as in B, part of it will be immersed in the intensification; and if again the triangle be turned by 180°, the line *m n o*, playing the part of a hinge, as at C, a larger proportion of its perimeter is exposed to contrast, and it will be cast at once into blackness. But what, may we ask, will be the observer's impression on the darkness of the indentation? Prompted by a zeal for detecting new features, and scrupulously recording every one of his impressions, he will be a little biased in favour of tracing to an objective source all the facts revealed by his exhausting scrutiny. He will not hesitate to consider the intensified estuary as corresponding to a real difference of tint; and areography will be enriched forthwith by the discovery of a brand new oasis.

Our apparent knowledge of Mars thus always exceeds our real knowledge, and this conclusion may be confirmed by further considerations. When a disc representing the appearance of the planet, without canals, is long examined in ordinary sunlight, the law of contrast causes the borders of the continents to appear fringed with a filiform whiteness, such as has been experienced by all Martian observers. In addition to this, however, the eye will detect a duller and much broader intensification of the "coasts," which, striking its roots in contrast also, runs parallel to, and at a distance from, the outline of the "Maria." The generally uniform albedo of the ruddy deserts is thus also shown to appear affected by physiological vagaries; and the unguarded observer, who cherishes the objectivity of his discoveries, will either lay stress on the brightness of the bordering lands, or insist on the duskiness of the adjoining wilderness. But the important point here is that the limit of the two tints is often raised to a canaliform darkness—a conclusion which justifies in some measure* Mr. Lane's theory that "the mere shape of the oceans of Mars is sufficient to give rise to the appearance of the complicated system discovered by Schiaparelli."†

"Canals" are thus artificially developed which happen to lie in the same positions as some of those discovered at Milan. If the "coast" is straight (Aeria), the concomitant "canal" is also straight (Phison); if the "coast" is curved (Libya), the "canal" is also curved (Nepenthes); and if the dark spot be oval (Solis Lacus), the bordering "canal" (Agathodæmon-Phasis) will run concentrically with the outline of its objective generator. Whether this constitutes a complete explanation of the "canals" in question or not it is scarcely wise to decide; but it seemed interesting to call attention to such a remarkable agreement between physiological necessities and the facts of experience.

It now remains to consider the effect of contrast on a dusky streak, such as the cigar-shaped Mare Cimmerium, whose broadest end evaporates into half-tones. Fixity of gaze should enhance its edges and brighten its interior into a cometary impression, exactly as seen by Schiaparelli.‡ Then again the narrow Sinus Sabæus should also present itself with a lighter interior, and the fleeting visibility of Xisuthri Regio is a literal corroboration of this statement. Scheria Insula in 1882, and Sirenia in 1892, furnish us with kindred examples. But this is a phenomenon which, according to Schiaparelli himself, is intimately related to gemination; and it is obvious that, by the forced enhancement of their edges, all lakes§ and all broad objective streaks or "canals" will appear duplicated. And thus, by a mere enquiry into the laws of contrast, the

* "Linee . . . . molto nere." *Memoria Sesta*, p. 74.
† *Ibid.*, p 75.

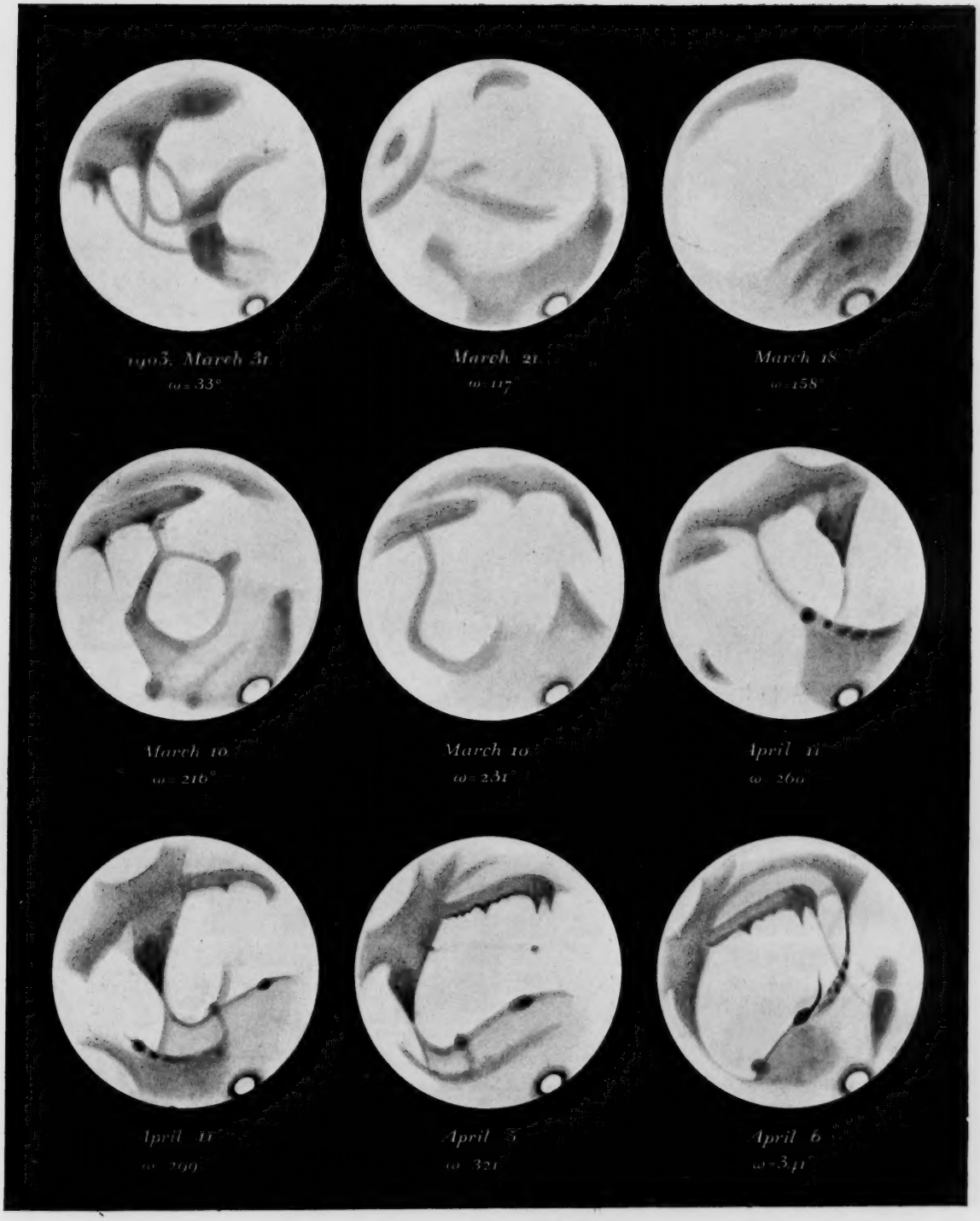
* Of course, contrast may account for such "canals" running parallel to the "coasts" a long way inwards; but it is incompetent to explain "canals" forming an angle with them. Hence Mr. Lane's theory is only partly confirmed by contrast.

† KNOWLEDGE for November, 1902, p. 250.

‡ Cimmeria Insula, in 1882.

§ The long examination of a small dusky eclipse tends to double it into round spots.

XUM



TELESCOPIC VIEWS OF THE PLANET MARS IN THE SPRING OF 1903.

Reproduced from Drawings by E. M. ANTONIADI.

XUM

XUM

appearance of Fig. 5, which summarizes our solid knowledge of the Martian surface, may be conjured, by fixity of gaze, into Fig. 6, or into a subjective breakdown of the

FIG. 5.—An Elementary View of our Real Knowledge of Mars.

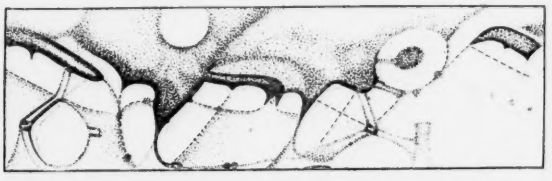


FIG. 6.—An Elementary View of our Apparent Knowledge of Mars.

Illustrating the Action of Contrast in generating "Canaliform" Sensations, as well as in decomposing the Tints of the Shadings, and thus probably paving the way for the Duplication of the Markings.

colour of all spots, as well as into a system of single-and-double canals. It would perhaps be imprudent to affirm at present that in contrast we have the sole and sufficient explanation of gemination. But what is at any rate certain is that it offers a very simple interpretation of at least a great many cases of doubling; and that the writer fails to see any fatal objection to it. Nor can we reasonably overlook the fact that whenever gemination has been playing havoc with the "canals" and "lakes," the phenomena of contrast have also been plainly evident in the appearances presented by the planet.

We are insensibly being brought to a standstill, and future enquiry on Mars must rather direct its efforts to the differentiation between subjective and objective in the known details, than in the discovery of novel complications and further developments in the "canal" system. By a singular fatality, the observations made with ordinary appliances in the smoky and troubled atmospheres of English towns have always equalled, and often excelled, those obtained with giant telescopes in the stillness of elevated deserts. Definition does not, therefore, improve in a direct ratio with an increase of height above the sea level, whilst an excess of instrumental power has itself proved powerless to reveal new features on a medal lying at the bottom of a shallow stream.

THE CANALS OF MARS.

By E. WALTER MAUNDER, F.R.A.S.

JUST a year ago a very interesting paper under the above heading by Mr. B. W. Lane appeared in KNOWLEDGE; in which he described a series of experiments tending to show that "the mere shape of the oceans of Mars is sufficient to give rise to the appearance of the complicated system discovered by Schiaparelli."* Mr. Lane's paper led to Mr. J. E. Evans, headmaster of the Royal Hospital School, Greenwich, and myself, undertaking together a series of experiments with boys in that school, from which some interesting results have been obtained. At the time when Mr. Lane's paper was published only a small proportion of these experiments had been carried out, and I was not therefore able to speak as definitely as I now can as to the conclusions to be drawn from them. These experiments were supplemented by others, made chiefly by Mrs. Maunder and myself, on the impressions produced by lines and dots when near the limit of vision, which further illustrate the subject.

The experiments at the Royal Hospital School were made in the following manner:—A class of about twenty boys, from twelve to fourteen years of age, were seated in four or five rows at different distances from a carefully-lighted diagram, which they were told to copy. The diagram was reproduced from some published drawing of Mars, but in nearly every experiment the canals were omitted. For the most part any boy was used in only one experiment; but a few were set to draw the same diagram twice, the second time at a different distance from the first. The diagram was generally about six inches in diameter, and the distances of the boys from the diagram ranged from fifteen to forty feet, except in two experiments where the range extended up to sixty feet.

One set of experiments is illustrated in the accompanying diagrams. Taking as basis Plate VIII. in Mr. Lowell's "*Mars*," showing the Mare Sirenum and the region north of it, we arranged three variations on it, on a scale of about six inches, and submitted them to three different sets of boys. The first variant (Fig. 1), showed chiefly the "oases"; the second (Fig. 3), only the "canals"; the third (Fig. 5), neither "oases" nor "canals," but irregular lines. The results of an experiment with the region of the Syrtis Major as subject are illustrated in the *Monthly Notices* of the Royal Astronomical Society, for June, 1903, Plates 18 and 19.

The general result was striking. In several of these experiments nearly all the boys drew "canals" on their copies, though there were none on the original from which they were copying. And these "canals" were not placed at random; they were just in the very places where canals are seen in the charts of Schiaparelli and Lowell. The boys agreed on the whole rather better in reproducing the position and direction of canals like Phison, Hiddekel, Euphrates, and Arnon, which were not on the original before them, than in reproducing the position and outlines of large and prominent markings like the Syrtis Major and Sinus Sabæus, which were very distinctly on the original.

But in no single case, out of considerably more than two hundred drawings, did we find a "canal" drawn, which seemed to owe its origin entirely to the shape of the neighbouring "oceans," or dark markings. Whenever the bright regions, the "continents," in the diagram, were left absolutely free from detail of any kind, then the copyists all, without exception, left it free also. We had not a single instance which could be taken as confirming Mr. Lane's result; at least in the form in which he has expressed it.

This result must be taken as negative only; we have no reason to assert that our experiments have disproved Mr. Lane's, only that they have not confirmed them. And an explanation of this difference in our results can be readily suggested. Mr. Evans and myself felt that the whole value of our experiments rested in the boys being left absolutely free from any suggestion, direct or indirect, that would lead them to suspect that there was something peculiar in the diagram which we wished them to see. We could not, therefore, press them to keep on staring at their model after they thought they had copied all there was to see. They did not strain their eyesight therefore, and so did not receive any of the impressions which strained eyesight

* KNOWLEDGE, 1902, November, p. 250.

might have occasioned. So far, therefore, as these experiments of ours go, we are not able to pronounce upon Mr. Lane's, either for or against.

Whence then did the "canals" come which were drawn by the boys of the Hospital School?

One cause was the prolongation of dark indentations invading the brighter regions. The Gehon and Hiddekel, for example, on the boys' drawings were clearly partly due to the two arms of Dawes' Forked Bay. This was my first suggestion as to the probable true nature of Schiaparelli's discovery, a suggestion made as long ago as 1882. But so far as our experiments go I do not think that many of the canals can be explained in this way. The Forked Bay and the two lakes Ismenius Lacus and Siloe Fons would be enough to some of our boys to show them Hiddekel and Gehon, but not to the majority.

A more fruitful source of the "canals" was the introduction of regions slightly darker or slightly brighter than their surroundings. Meroe Island figured as an example in the first category, Elysium as one in the second, in two different experiments. And no one could wish for straighter and sharper "canals" than were drawn by a good proportion of the boys to express these regions. A few put in shading, fewer still put in shading and drew also a dark canal as its boundary. There can, I think, be no reasonable doubt that Mr. Green, when in 1879 he suggested that the borders of faint shadings might have given rise to some of the canals, pointed out a cause not only equal to producing such an effect, but one that does so in reality.

Another cause which proved decidedly effective was the tendency of the eye to join together two small spots, where these were not too small to be separately seen, by a wholly subjective line. But the cause which was the most effective within the limits of our experiments with the Hospital School boys was the way in which the eye summed up together minute irregular markings, each too small to be separately perceived as straight streaks. An examination of the drawings with reference to the placing of the boys rendered this very evident. At fifteen or seventeen feet the boys were near enough to detect some, if not all, of the minuter details as separate entities, and hence drew few canals. At thirty-five or thirty-eight feet these details were for the most part too small to produce any effect, even in the gross, and therefore the boys here also drew few if any canals. But between these two extremes nearly every boy drew canals. Halfway between them every boy without exception saw "canals." For here, whilst the details were each one separately invisible, they were yet capable of creating in the sum a distinct impression.

And, seen at this distance, it was very striking to see how the eye, as it were "took the average" of all irregularities. Two irregular wavy lines drawn so as to cross each other, took form as a beautiful "oasis" with four straight canals radiating from it. Lines as meandering as the Thames or Trent with their tributaries on a map of England, straightened out as rigidly as the Phison or Euphrates on Lowell's chart. If Mr. Lane's effects were never secured with an entirely blank "continent," it was astonishing to see how effectively three or four dots, absolutely invisible at the distances occupied, would suffice to make those effects plain. Nor was it at all necessary that the dots should be put in a straight line where the canal ought to run. They might wander from it a good deal on either side, if only the mean line between them ran in the right direction.

It may be objected that very little has been gained if we recognise that the canals are either the edges of half-tone districts, or the summation of very minute details. The general distribution of the true markings on the planet must approximate to that shown on the charts of Schiaparelli and Lowell, and the details if not straight lines in their ultimate conceivable resolution are at least straight lines to the eye.

FIG. 1.—Original. "Oases" only.

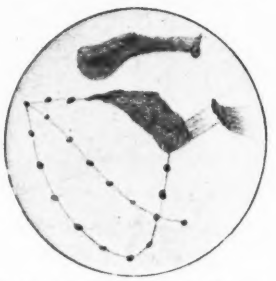


FIG. 2.—Copy of Fig. 1 at distance 23 feet.

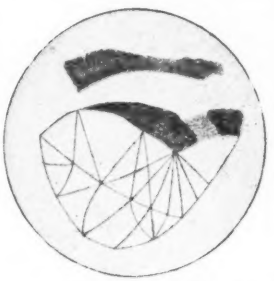


FIG. 3.—Original. "Canals" only.

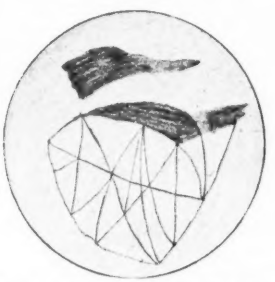


FIG. 4.—Copy of Fig. 3 at distance 22 feet.

FIG. 5.—Original. Irregular lines.

FIG. 6.—Copy of Fig. 5 at distance 33 feet.

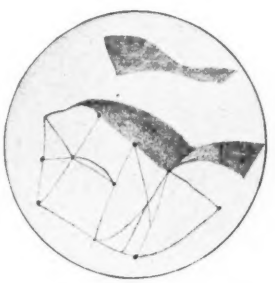


FIG. 7.—Copy of Fig. 5 at distance 24 feet.

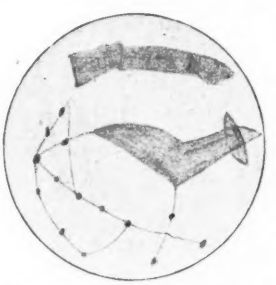


FIG. 8.—Copy of Fig. 1 at distance 28 feet.

The Region of the Mare Sirenum (with variations).

But the gain is really great. For so long as we conceive of that elaborate reticulation as being a true feature of the actual surface of the planet, we can hardly escape from Mr. Lowell's induction. Lines so straight, so formal, so

uniform in width, so regular in their intersections, so symmetrical, with dark spots so inevitably marking their intersections, must be accounted, as he accounts them, artificial; the handiwork of intelligent beings. But if actual details of perfectly irregular and unsymmetrical character, details having no sign of artificiality about them, can present exactly the appearance, and make just the impression which the network of the canal system does, the argument for the existence of inhabitants on Mars has vanished. We are freed, too, from the necessity of considering such bizarre theories as would make out the planet to have been scored into its present form by grazing meteorites, or to have assumed it through crystallization. To have been set free from the grotesque in observation is to have been freed also from the grotesque in speculation.

This service I think the drawings of the Hospital School boys have effectually rendered to us. They have shown that perfectly unbiased observers will see and draw the Schiaparellian canals when the actual markings presented to them are as little regular and artificial as any which our own earth might present to an outside spectator.

I do not think we need claim more for these experiments than this; a complete explanation of the canal system would probably involve other factors than those indicated above. Thus a most able letter by M. Antoniadi, which appeared in the *English Mechanic* for July 31st, 1903, sums up the canal-impression under five heads:—

"(*a*) Entirely physiological markings, like those seen by Mr. Lowell on other planets, by myself on Mars, and by Mr. Lane on his artificial discs.

"(*b*) Subjective lines, generated by the topographical details.

"(*c*) Edges of physiological half-tones, begotten by contrast.

"(*d*) Edges of objective half-tones, arising from the same reason. And

"(*e*) Incontestably real canals, which, were we to see Mars better, would resolve themselves into groups of knotted or unevenly shaded areas."

This classification cannot be much bettered with our present knowledge. I should myself give the first place to *b* as the most fruitful source of canals, and the next to *d*, these two classes being those with which our Greenwich experiments were concerned. The two physiological classes, *a* and *c*, were not included in our work. But I am inclined to think that they are intimately combined with the others in producing the canal system as we know it; and that its geometrical appearance is largely due to them. In the last class *e*, I should myself prefer to withhold the name "canal" from features which, like Nasmyth Inlet and Huggins Inlet, were well known long before the canal system as such had its commencement. I well remember that my first disposition to be sceptical of Schiaparelli's discoveries arose from the fact that he drew so many canals which I could not see at all as being equally distinct with Nasmyth Inlet which I had seen conspicuously. That may have been a bit of personal bias, but I think it is clear that whilst the canal system as a whole must be considered as subjective only, some markings which have been included in it have been too thoroughly well defined to be anything but real. At the present moment the most interesting feature with regard to the entire discussion is the tendency of the ablest and most favourably circumstanced observers to see the chief canals no longer as straight uniform lines, but as close sequences of spots, as if an approach had been made to their complete resolution. It is now a quarter of a century since the canals as such were first introduced to us. It may well be that the next quarter of a century may see such an advance that ere its close we may have detected the actual component details of what we now consider as straight lines, and that therefore the canals—as such—may have entirely disappeared.

MODERN COSMOGONIES.

By AGNES M. CLERKE.

V.—THE FISSION OF ROTATING GLOBES.

FEW people need to be told that a rotating fluid mass is shaped very much like an orange. It assumes the form of a compressed sphere. And the reason for its compression is obvious. It is that the power of gravity, being partially neutralised by the centrifugal tendency due to axial speed, gains progressively from the poles, where that speed has a zero value, to the equator, where it attains a maximum. Here, then, the materials of the rotating body are virtually lighter than elsewhere, and consequently retreat furthest from the centre. The "figure of equilibrium" thus constituted is a spheroid, a body with two unequal axes. In other words, its meridional contour—that passing through the poles—is an ellipse; while its equator is circular.

Now we know familiarly, not only that a spinning sphere becomes a spheroid, but that the spheroid grows more oblate the faster it spins. The flattened disc of Jupiter, for instance, compared with the round face of Mars, at once suggests a disparity in the rate of gyration. But there must be a limit to the advance of bulging, or the spheroid, accelerated *ad infinitum*, would at last cease to exist in three dimensions! Clearly this unthinkable outcome must be anticipated; at some given point the process of deformation must be interrupted. A breach of continuity intervenes; the train is shunted on to a branch line. Nor is it difficult to divine, in a general way, how this comes to pass. Equilibrium, beyond doubt, breaks down when rotation attains a certain critical velocity, varying according to circumstances, and the spheroid either alters fundamentally in shape, or goes to pieces.

So much plain common sense teaches; yet the precise determination of the course of events is one of the most arduous tasks ever grappled with by mathematicians. M. Poincaré essayed it in 1885*; it was independently undertaken a little later by Professor Darwin†; and the subject has now been prosecuted for eighteen years, chiefly by these two eminent men, with a highly interesting alternation of achievement, one picking up the thread dropped by the other, and each in turn penetrating somewhat further into the labyrinth. The results, nevertheless, are still to some extent inconclusive; they indicate, rather than indite, the genetic history of systems. A strong light is, indeed, thrown upon it; but in following its guidance, the limitations of the enquiry have to be borne in mind. The chief of these are, first, that the assumed spheroid is liquid; secondly, that it is homogeneous. Neither of these conditions, however, is really prevalent in nature, so that inferences based upon them can only be accepted under reserve. They were adopted, not by choice, but through the necessities of the case. There was no possibility of dealing mathematically with bodies in any other than the liquid state. The equilibrium of gaseous globes defies treatment, except under arbitrary restrictions.‡ Nor is it possible to cope with the intricacies of calculation introduced by variations of interior density. Cosmical masses, as they actually exist, are nevertheless strongly heterogeneous, so that, at the utmost, only an approximation to the genuine course of their evolution can be arrived at by the most skilful analysis. Yet even an approximate

* "Acta Mathematica," Vol. VII., Stockholm, 1885.

† *Proc. Royal Society*, Vols. XLII., LXXI.; *Phil. Trans.*, Vols. CXCVIII., CXCIX., Series A.

‡ J. H. Jeans, *Phil. Trans.*, Vol. CXCIX., A., p. 1.

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solution of such a problem is of profound interest. We can here only attempt briefly to specify its nature.

The overthrow of equilibrium in a rotating liquid spheroid has, at any rate, been satisfactorily tracked. When its gyration quickens to a disruptive pitch, it acquires three unequal axes instead of two. The equator becomes elliptical like the meridians. A "Jacobian ellipsoid" is constituted. This new form seems to have had, in growing systems, a long spell of stability; only its major axis became more and more protracted as cooling progressed, and with cooling, contraction, and with contraction, the increase of axial velocity. Then at last a crisis supervened; there was a collapse of equilibrium, and its re-establishment involved the sacrifice of the last vestige of symmetry. An "Apioid" or pear-shaped body replaced the antecedent ellipsoid; and its apparent incipient duality suggested to M. Poincaré that the furrow unequally dividing it might have deepened, with still accelerated gyration, into a cleft, splitting the primitively single mass into a planet and satellite. But this eventuality, he was careful to note, had no direct bearing on Laplace's hypothesis, which dealt with a nebula condensed towards the centre, while the fissured apioid was liquid and homogeneous.*

Professor Darwin followed out the conditions of this remarkable pear-shaped body to a closer degree of approximation than its original investigator had done, and succeeded in virtually demonstrating its stability. His analysis, however, tended to smooth away the characteristic peculiarities of its shape, and, so far, to diminish the probability of its ultimate disruption. Mr. Jeans, on the other hand, from an elaborate study of a series of cigar-shaped figures which in theory follow a parallel course of development to that pursued by ellipsoids, derived, by strict mathematical reasoning, the actual separation of a satellite from one end of a parent-cylinder. The representative figures reminded Professor Darwin "of some such phenomenon as the protrusion of a filament of protoplasm from a mass of living matter." "In this almost life-like process," he saw "a counterpart to at least one form of the birth of double stars, planets, and satellites."†

But the resemblance, when examined dispassionately, seems shadowy and evasive; nor can we be sure that it extends to the case of double stars. Here, indeed, an entirely different set of conditions comes into play from that postulated by Poincaré and Darwin, since stars are certainly not liquid bodies. They are most likely gaseous to the core; though the indefinite diffusiveness incident to gaseity is restricted by their condensed photospheric surfaces. This circumstance intimates the possibility that the results arrived at for liquid globes by mathematical analysis may, with qualifications, be extended to stars; but the necessary qualifications, unfortunately, are vague and large; for too little is known regarding the physical condition of stellar spheres to warrant assumptions that might provide a secure basis for research. The evolution of binary stars can then only be treated of inferentially, not rigorously; and we must, at the outset, discard the idea that it is illustrated by the phenomena of double nebulæ. Many such objects, thought to supply clinching visual arguments for the actual effectiveness of slow cosmic fission, proved, on the application to them of the late Prof. Keeler's searching photographic methods, to be knots on spiral formations. Their mutual relations are then entirely different from what had been supposed by telescopic observers; they are, in fact, still structurally connected, and the mode of their origin, however inviting to conjecture, scarcely comes within the scope of exact enquiry. Their future destiny is no more accessible to it than their past history; and only by a daring flight of imagination can we see in spiral nebulæ the prototypes of double stars.

Questions as to the mode of genesis of these latter systems have, in recent years, acquired extraordinary interest. Conclusive answers cannot, indeed, at present be given to them, because the terms in which they are couched lack definiteness owing to our lack of knowledge; but probable answers may legitimately supply their place, at least *ad interim*, especially when their probability is heightened almost to certainty by the accumulation of circumstantial evidence.

Observations and investigations of stellar eclipses have created a new department of astrophysics, and have vastly widened the domain of cosmogony. For they have brought to notice a number of systems, not merely in a primitive, but seemingly in an embryonic stage of development. The periods of occulting stars are nearly all of less than seven days, although one extending to thirty-one has lately been recognised; and the comparative length of the intervals of obscuration shows them to be produced by the circulation in narrow orbits of voluminous globes. These are characteristic symptoms of juvenility; since, as we have seen, orbits widen and periods lengthen with the efflux of time, through the frictional power of bodily tides. Now the class of stars which obviously and certainly undergo eclipses has some outlying members of a still dubious nature. And their critical position serves greatly to enhance the present, the prospective, and the retrospective interest attaching to them. These remarkable objects vary in light continuously. Their phases are not, like those of Algol, mere interruptions to a regular course of steady shining. They progress without a moment's sensible pause; they are represented graphically by a smoothly-flowing, symmetrical curve. The eclipses by which they are occasioned—if they are so occasioned—must, accordingly, succeed each other in a strictly unbroken series. No sooner has one terminated than the next commences. One star passes first behind, then in front of its companion, and their combined brightness is seen undimmed only during the few moments of actual maximum. This means that they revolve in contact; they are separated by no sensible gap of space.

Goodricke's variable, β Lyræ, is held to be thus constituted. The possibility, at any rate, of employing the "satellite-theory" to account for its changes was demonstrated some years ago by Mr. G. W. Myers, of Indiana.* He found the system to be composed of two barely separated ellipsoids, circulating in the visual plane, and producing, by their successive transits, two unequal eclipses in the course of each period of 12·91 days. The joint mass of the pair is just thirty times that of our sun; but their mean density has the almost incredibly small value of $\frac{1}{1200}$ that of water. Their real existence is conditional upon the possibility that masses much more tenuous than atmospheric air should radiate with the intensity of true suns. Spectroscopic observations are not wholly unfavourable to Mr. Myers's hypothesis, but their interpretation is hampered by discrepancies so numerous and perplexing that no secure inference can he derived from them. Moreover, the star supposed to be alone presented to view at the principal minimum is that giving the bright-line spectrum; yet it is compulsorily assumed, in order to meet the exigencies of the situation, to be much more massive, while much less intrinsically bright than its companion. This is disquieting; but nearly everything connected with β Lyræ *is* more or less disquieting.

* "Figures d'Équilibre d'une Masse Fluide," p. 172.

† *Proc Roy. Society*, Vol. LXXI., p. 183.

* *Astrophysical Journal*, Vol. VII., p. 1.

A variable of the same type, but much fainter, was made the subject of a similar enquiry by Mr. Myers in 1898.* U Pegasi never attains ninth magnitude; hence spectroscopic complications equally with spectroscopic verification remain at present out of sight. The star, nevertheless, excites keen interest, and claims sustained attention. Its light-curve has been laid down with exquisite accuracy at Harvard College, and shows two slightly unequal minima to be comprised within a period of nine hours, signifying, on the adopted theory, the occurrence of alternating eclipses at intervals of 4½ hours. The distance from centre to centre of the occulting stars, the smaller of which is of about eight-tenths the brightness of the larger, "does not materially differ," Mr. Myers tells us, "from the sum of their radii, suggesting the probable existence of the 'apioidal' form of Poincaré." If they do not actually coalesce, the component bodies revolve in contact, and rotate synchronously. Thus it is hard to say whether U Pegasi should be accounted as a single pear-shaped mass spinning in the time of light-change, or as a close couple circulating freely in an identical period. The mean density of the system appears to lie between one-third and one-fourth that of the sun.

Another specimen of the "dumb-bell" system is perhaps met with in R^2 Centauri. The narrow range of its variation makes it a delicate object to observe; but Mr. A. W. Roberts, who first noticed its peculiarity in 1896, has since accumulated an extensive series of wonderfully accurate visual determinations of its fluctuating brightness, and has besides rendered them the basis of an able and exhaustive theoretical discussion.† The double period of R^2 Centauri is restricted to 14h. 32m. Within this brief span quadruple phases are included—that is to say, two evenly-balanced maxima, and two inconsiderably disparate minima. These result, Mr. Roberts concludes, from the mutual eclipses of interpenetrating ellipsoids, one somewhat more luminous than the other, revolving—if they can properly be said to revolve—in an orbit inclined 32° to the visual plane. They are of just one-third the solar density, and the forms satisfying photometric requirements by the varying areas of luminous surface presented to sight in different sections of their path show a surprising agreement with the bi-prolate figure given by Prof. Darwin's analysis as the shape of a body on the verge of disruption through accelerated rotatory movement. The inference is, then, almost irresistible that R^2 Centauri really exemplifies the nascent stage of binary stars. To establish this completely, however, spectroscopic data are needed; and they are difficult to procure for a star below the seventh magnitude.

No such obstacle impedes the investigation of the analogous, but much brighter star V Puppis. Detected as a spectroscopic binary by Prof. Pickering in 1895, this star traverses so wide an orbit in the short period of thirty-five hours as to imply—if the published details are correct—that the pair possess no less than 348 times the gravitational power of the sun. They are, nevertheless, according to Mr. Roberts, fifty times more tenuous, and each globe should have a diameter of about 16½ million miles; all which, though startling, is not incredible. The light-curve of V Puppis, as traced by Mr. Roberts, is closely modelled upon that of U Pegasi. And he postulates similar conditions of eclipse. It rests, however, with the spectroscope to determine whether those conditions are realised or not.

Probably all short-period variables are binaries, with coincident orbital- and light-cycles. But all are not occulting binaries. There are some—we are still ignorant of their proportionate numbers—which undergo a course of light-change, apparently compatible with an occulting hypothesis, yet certainly escape eclipse. Prof. Campbell has made it unmistakably clear that ζ Geminorum is thus constituted.* Two stars are present, but their plane of motion is inclined at an unknown angle to the line of sight; it does not approximate to coincidence with it. Now the possibility is not excluded that V Puppis belongs to the same class. Mr. Roberts's assumptions are indeed in themselves extremely plausible, and they may at any moment be proved, by a few well-timed spectrographs to be undeniably true. The one conclusive test is the cessation of radial movement at epochs of minimum. Evidently, if the diminution in lustre be in fact due to an eclipse, the eclipsing and eclipsed bodies must be crossing the line of sight just when the obscuration is deepest. There is no evading this geometrical requirement; and it must be rigorously complied with in the circular orbits traversed by bodies revolving in contact. Before, then, Mr. Roberts's theory of V Puppis can be accepted with implicit confidence, it has to be ascertained whether a zero of radial speed is reached concurrently with the photometric minima. If so, they may be unhesitatingly accounted eclipse-phenomena; if, on the contrary, the decline in brightness prove to be unrelated to a slackening of speed, then the supposition that it accompanies and indicates a transit must be peremptorily discarded. Moreover, the spectroscopic verdict as regards V Puppis can safely be applied to stars with similar light-curves, especially to R^2 Centauri and U Pegasi, and may serve to clear away some of the intricacies connected with the exceptional system of β Lyræ. The measurement of a single spectrographic plate might thus be made essentially to supply the lack of many desirable, but at present unattainable, determinations.

The existence of stellar systems of the "dumb-bell" type would violate no mechanical law. "Roche's limit" does not apply to globes comparable in size. The range of disparity within which it holds good has not, it is true, been theoretically established; but it may be said, in general terms, to concern the relations of planets and satellites (to use a purposely vague phrase), not those of double stars. What the law asserts is that a subordinate small body cannot, if their mean density be the same, revolve intact at a less distance than 2·44 radii of its primary from that primary's centre. For satellites of slighter consistence the limit should be extended. Our own moon, for instance, could never have circulated, without being rent in pieces by tidal strains, in an orbit less than 22,000 miles in diameter.† Bodies of co-ordinate mass are, however, exempted from the prohibitive rule against mutual approach. No analytical veto is imposed upon the origin by fission of double stars, or upon the subsistence of stellar Siamese twins. The inequalities in attractive power of co-ordinate masses avail for distortion, not for disruption. Their individuality, therefore, once created, is in a manner indestructible. It tends, in fact, to become more pronounced as the orbital span gradually widens through tidal friction. The "dumb-bell" condition may, accordingly, be, comparatively speaking, transitory. Nor can we be assured of its subsistence otherwise than by the peculiar nature of the eclipses attending upon it, taken in connection with spectroscopic observations of decisive import. The disclosure, by such means, of systems so strangely conditioned, affords a deeper insight than would else have been possible into the cosmical order, and fills a blank page in the genetic history of the sidereal world.

* *Astrophysical Journal*, Vol. VIII., p. 163.
† *Monthly Notices*, Vol. LXIII., p. 627.

* *Astroph. Jour.*, Vol. XIII., p. 90; *Science*, July 27th, 1900.
† G. H. Darwin, "The Tides," p. 325.

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Notes.

ASTRONOMICAL.—Another contribution to the study of the relation between solar activity and terrestrial magnetism was set forth by Father Cortie in a paper read at the recent meeting of the British Association The point to which special attention was given was to determine if large and violently eruptive prominences, in the absence of spots, were responded to by magnetic disturbances, and from a discussion of the prominence observations for the years 1887-88 it was found that in no single case could a magnetic storm be definitely associated with any particular prominence outburst, while great eruptive prominences occurred with no accompanying magnetic storm. It is concluded that the earth's magnetism is not affected directly by any particular spot or prominence, but by the general disturbance of the sun and his surroundings.

In an interesting letter to *The Observatory*, Mr. J. E. Gore draws attention to a description of Sirius given by Al-Sûfi, the Persian astronomer in the tenth century. It is stated that "the Arabians call the brilliant and great star which is in the mouth *al-schira al-abûr*, Sirius which has passed across. . . . It is called *al-abûr* because it has passed across the Milky Way into the southern region." Mr. Gore points out as a remarkable fact that the proper motion of Sirius (1″·31 per annum in the direction of position angle 204°) would have carried it across the Milky Way in about 60,000 years, and suggests that a mythological story related by Al-Sûfi as to why Sirius fled towards the south may be based on a tradition of Sirius having been seen on the opposite side by men of the Stone Age. At all events, the Arabic name *al-abûr* denotes an actual fact. Al-Sûfi further says that when Sirius passed across the Milky Way, Procyon remained in the region to the north-east of the Milky Way, which is also accordant with the known amount and direction of the proper motion of this star; 60,000 years hence, Procyon will also have crossed the Milky Way.—A. F.

METHOD FOR ASCERTAINING THE MOON'S AGE.—Mr. Holmes' method for ascertaining the moon's age may be explained in the following manner. It depends, first of all, on the "Metonic cycle." Nineteen solar years correspond to 235 lunations; hence the new moons in one year correspond to those in the years 19 years earlier or 19 years later. This gives the first part of the rule, the effect of which is to divide all years into 19 classes, and corresponds in effect to the finding of the "Golden Number." The relation of any one year of a Metonic cycle to the next year of that cycle is given by the "Epact"—the age of the moon on the first day of the year. Since twelve lunations include 354 days, and a solar year 365 days, the epact of any year is 11 days greater than that of the preceding year. When the epact amounts to more than an entire month, only the odd days are counted. This gives us, in effect, the second part of the rule. There remains only the last part. January and February together make up two complete lunations. For the remaining months of the year, each is on the average one day longer than a complete lunation, so that the day of the new moon, *on the average*, falls one day earlier in each month after March. The year 1900 is divisible by 19 without remainder, and in this year the first new moon fell on January 1, so that for the month of January the day of the month gave at once the age of the moon. The rule then follows from the above principles. It is necessarily quite a rough one, and will often be two days in error, but as an instantaneous way of getting an approximate idea of the moon's age, it has its use.—E. W. M.

ZOOLOGICAL.—Those of our readers who studied the articles on "The Palæontological Case for Evolution" recently published in this journal should be interested in a memoir on the ichthyosaurs, or fish-lizards, of the Triassic strata of California, issued in the *Geological Bulletin* of the Californian University. Compared with their descendants of the Lias, these Triassic species were quite small. Their most interesting feature is, however, the structure of the paddle, in which the component bones are much more elongated, and therefore less unlike the corresponding elements of normal reptiles, than are those of the true ichthyosaurs of the Lias. An important step is thus made in tracing the origin of the group.

Unlike chimpanzees, which have long since been recorded from Uganda, gorillas have hitherto been supposed to be confined to the west coast of Africa. Much interest attaches therefore to the discovery of a representative of these apes high up on Mount Kirunga, nearly midway between Lakes Albert Edward and Kivu. Dr. Matschie, of Berlin, has described the animal as *Gorilla beringei*.

Mr. Pycraft's memoir on the osteology of owls, recently published in the *Transactions* of the Linnean Society, is an important contribution to our knowledge of birds' skeletons. Had we to deal with the skeleton alone, it is probable that owls would never have been separated in systematic zoology from the diurnal birds of prey. The soft parts are, however, very different in the two groups, and all the evidence points to the near affinity of the owls to the goat-suckers. Very curious is the discovery that the Nepalese horned owl differs from all its relatives in regard to the notching of the breast-bone. Whether, however, this necessitates its reference to a genus apart, may be a matter of opinion.

Some years ago an article, by Mr. Lydekker, appeared in this journal on the nursing habits of frogs. In the October issue of the Zoological Society's *Proceedings*, Mr. Boulenger describes the mode in which the eggs are carried by the female of a rare frog (*Ceratohyla bubalus*) from the Peruvian Andes. In the one specimen obtained with eggs, there were nine of these tightly adhering to the skin of the back, in which the spines of the vertebræ were so prominent as to leave indentations in the egg-membranes. Fully-formed young frogs were seen in the eggs.

ERRATA.—In Mr. A. C. D. Crommelin's articles on Cycles of Eclipses in KNOWLEDGE for September, p. 205, 2nd column, 5th line from bottom, for "N. Dec. 92° 27′" read "N. Dec. 9° 27′"; for October, p. 226, description under Plate IV., for "1085 years earlier," read "1805 years earlier."

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

Sooty Tern (Sterna fuliginosa, Gm.) *in Suffolk* (*Field*, October 3rd, 1903, p. 600).—Mr. W. A. Dutt here records that he lately found a fine adult specimen of this Tern in the possession of Mr. J. Nunn, of Santon, Downham. The bird was found dead at Santon Downham Warren in the spring of 1900. Mr. Thomas Southwell has confirmed its identification. The Sooty Tern is an inhabitant of the Pacific, but it occurs as far west as the Indian Ocean and the Red Sea. It is a rare wanderer to Europe, and has only been recorded three times, previously to the above instance, in England.

Dartford Warbler in Shropshire (*Zoologist*, 1903, September, p. 349).—Mr. H. E. Forrest records that a pair or two of Dartford Warblers has been found breeding near Ludlow, in Shropshire, this summer. This is a north-western extension of the known breeding range of this bird. It is a species easily overlooked, owing to its secretive habits, and it is quite probable that Dartford Warblers have long made use of this newly-found breeding place.

Tree Sparrow in Shetland (*Ann. Scot. Nat. Hist.*, 1903, p. 211) *and in the Isle of Man* (*Zoologist*, 1903, p. 313).—For some years the Tree Sparrow has been extending its range. Fifty years ago it was unknown in Ireland, but it is now resident and increasing in numbers there. Mr. F. S. Graves now reports it from the Isle of

Man, where it probably breeds, and Dr. T. E. Saxby finds a pair nesting in West Shetland.

Wigeon Breeding in Ireland—A Correction (*Irish Naturalist*, 1903, October, p. 275).—In 1901, Mr. Robert Patterson recorded that the Wigeon had bred near Belfast (*see* KNOWLEDGE, 1901, pp. 183 and 205). A bird was flushed from one nest, but was not identified apparently. Mr. Patterson now frankly admits that a mistake has been made, and that the record must be cancelled. The eggs and the down agreed with those of the Wigeon, but, through Mr. Heatly Noble, Mr. Patterson has learnt that the down is not always a reliable test for the identification of duck's eggs, and an examination of the small feathers mixed with the down from this nest has proved that they belonged to the Shoveler.

An Unknown Warbler in Oxfordshire. By W. Warde Fowler, M.A. (*Zoologist*, 1903, September, pp. 343–348).—In these days of the rigid protection of birds this article should prove instructive to those who favour extreme protection, as well as to the ornithologist. Mr. Warde Fowler and several of his friends have been watching for the last three years a small Warbler in a wood near Oxford. They have been quite unable to identify the bird, and would not shoot it, and the results of their observations are detailed at length by Mr. Fowler in the hope that some one may be able to identify the bird by the details given. From a scientific point of view these observations are quite worthless without the identification of the bird, which is impossible from the details obtained. Much personal pleasure was enjoyed, no doubt, by the observers in watching the bird, and in collecting these details, but those who advocate protection at all costs should bear in mind that without the knowledge of birds obtained by systematic study, as well as by observation in the field, protection of birds would never have been possible.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at the Office of* KNOWLEDGE, 326, *High Holborn, London.*

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

RADIUM AND THE SUN'S HEAT.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The interesting article on radium in KNOWLEDGE for October prompts me to inquire whether the heat-giving property of its complicated atom can be called in aid to explain more satisfactorily the source of the sun's heat? Do we see any analogy at all between this minute atom and the mighty globe of the sun in their heat-giving and heat-maintaining properties? Or does the discovery of the new element explode the present theory of the source of the sun's heat? P. J. DAMANIA.

2nd October, 1903.

[There is no doubt that the discovery of radium compels us to abandon completely some of the conclusions, based upon present theories of the origin of the sun's heat. Mr. W. E. Wilson calculates that "3·6 grammes of radium per cubic metre of the sun's volume would supply the entire output" of the sun's energy. He further suggests that at the temperature of the sun, radium may be much more energetic than at our terrestrial temperatures. If so a much smaller weight of radium per cubic metre may suffice. The computations which Lord Kelvin and other leading men of science have made as to the possible length of time in the past, and in the future, during which the sun could maintain its present energy of radiation, are necessarily entirely set aside, for we can no longer assume that the concentration of the sun's substance from infinite distance has been the sole or even the chief source of its energy. It is not only that radium itself may exist in sufficient abundance in the sun to account for its energy, but the same or similar radio-active properties may be possessed by other of its elements, or by the sun itself as a whole. Prof. G. H. Darwin writes: "Knowing as we now do that an atom of matter is capable of containing an enormous store of energy in itself, I think we have no right to assume that the sun is incapable of liberating atomic energy to a degree at least comparable with that which it would do if made of radium" (*Nature*, 1903, September 24th, p. 496).—E. WALTER MAUNDER.]

THE LEONID METEORS AND THE MOON.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—An investigation into the circumstances connected with the occurrences of the Leonid star-showers shows that there subsists the following relationship between these phenomena and the moon. All the Leonid meteor-showers on record have taken place either at or between new moon and first quarter, or else at or between full moon and last quarter, with the lunar perigee generally placed at or between full and new moon, the intensity of the phenomenon being greater the nearer the perigee and moon were to her phases of new or full. In the following table a list of these historic star-showers, as given by Prof. Newton in the "Encyclopædia Britannica," Vol. XVI., p. 110 (9th Edition), is presented, together with the positions of the moon and perigee at the time of each display:—

Date of Shower.	Moon New (●) or Full (○). (Nearest to Shower.)	Moon in Perigee.
902, Oct. 13 (O.S.)	○ Oct. 20 (O.S.)	Oct. 21 (O.S.)
931, Oct. 15 „	● Oct. 14 „	Oct. 13 „
934, Oct. 14 „	● Oct. 11 „	Oct. 18 „
1002, Oct. 15 „	● Oct. 9 „	Oct. 8 „
1101, Oct. 17 „	● Oct. 24 „	Oct. 25 „
1202, Oct. 19 „	● Oct. 18 (○ Nov. 1) „	Nov. 1 „
1366, Oct. 23* „	○ Oct. 19 (● Nov. 3) „	Nov. 3 „
1533, Oct. 25 „	● Oct. 18 „	Oct. 17 „
1602, Nov. 7 (N.S.)	● Nov. 14 (N.S.)	Nov. 5 (N.S.)
1698, Nov. 9 „	● Nov. 2 (○ Nov. 18) „	Nov. 18 „
1799, Nov. 12 „	○ Nov. 12 (● Oct. 28) „	Oct. 28 „
1832, Nov. 13 „	○ Nov. 8 „	Nov. 12 „
1833, Nov. 13 „	● Nov. 11 „	Nov. 8 „
1866, Nov. 14 „	● Nov. 7 (○ Nov. 22) „	Nov. 22 „
1867, Nov. 14 „	○ Nov. 11 „	Nov. 14 „
1863, Nov. 14 „	● Nov. 14 „	Nov. 9 „

* The moon became full in October, 1333, on the evening of the 19th.

The star-shower took place in each instance on the morning of the date given, and therefore local time is used. These displays occurred without exception at or between the time of new moon and first quarter, or else at or between the opposite lunar phases. Our satellite at the time of these showers was thus confined to two opposite quadrants which together equal one-half of her orbit. As far as it is a question of chance, the moon was just as free at any one of these showers to have been in the remaining half. It is excessively improbable, therefore, that this peculiar position of the moon in sixteen successive instances should have been due to mere coincidence. As regards the position of the perigee there is only one notable exception, viz., in the shower of 934, when the perigee was near the moon's first quarter. This display was of a feeble character, judging from the ancient account of it. We know from the records describing these phenomena (*American Journal of Science and Arts*, 1864, No. 111), that the showers of 1202, 1366, 1799, and 1833 far surpassed the others in brilliancy, and that the meteors were or must have been seen in tens of thousands. These intensely brilliant spectacles were witnessed at or immediately after the time of new or full moon. It may also be observed that at the time of the occurrence of the first three of these famous star-showers, the moon was moving in an orbit of almost maximum eccentricity, having been in perigee within a few hours of the time when she was new or full.

It is, perhaps, not surprising to find that the law which

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thus appears to regulate the moon's position in the great meteoric phenomena, should also be illustrated in minor and irregular falls of Leonid meteors. Of all meteor-systems the Leonids exhibit the best-marked periodicity; but, as has been remarked by observers, shooting stars from Leo may make their appearance sometimes as much as a week before or after the mean epoch. Such of these minor or irregular displays as occurred before 1833 must have been by far the most remarkable, as they were not specially looked for, and, therefore, must have been of considerable splendour to have attracted casual observation. In the following table the dates of these displays, mostly taken from Arago's "Astronomie Populaire," Vol. IV., pp. 308-312, are given with the time when the moon was new or full and in perigee:—

Date of Shower.	Moon New (●) or Full (○). (Nearest to Shower.)	Moon in Perigee.
288, Sept. 28 (O.S.)	○ Sept. 27 (O.S.)	Sept. 21 (O.S.)
855, Oct. 18 ,,	● Oct. 15 ,,	Oct. 23 ,,
856, Oct. 18 ,,	○ Oct. 17 ,,	Oct. 16 ,,
1606, Nov. 15 (N.S.)	○ Nov. 14 (N.S.)	Nov. 3 (N.S.)
1787, Nov. 10 ,,	● Nov. 10 (○ Nov. 25) ,,	Nov. 26 ,,
1813, Nov. 8 ,,	○ Nov. 8 ,,	Nov. 9 ,,
1818, Nov. 13 ,,	○ Nov. 12 (● Nov. 28) ,,	Nov. 29 ,,
1818, Nov. 19 ,,	○ Nov. 12 (● Nov. 28) ,,	Nov. 29 ,,
1820, Nov. 12 ,,	● Nov. 6 ,	Nov. 17 ,,
1822, Nov. 13 ,,	● Nov. 13 (○ Nov. 28) ,,	Nov. 29 ,,
1823, Nov. 13 ,,	○ Nov. 18 ,,	Nov. 21 ,,
1826, Nov. 7 ,,	● Oct. 31 ,,	Oct. 31 ,,
1828, Nov. 12 ,,	● Nov. 7 ,,	Nov. 14 ,,
1831, Nov. 13 ,,	○ Nov. 19 (7 p.m.) ,,	Nov. 20 ,,
1832, Nov. 15 ,,	○ Nov. 8 ,,	Nov. 12 ,,

Prof. Kirkwood has given the date of the first of these displays, which he regarded as being connected with the present mid-November meteor-system. Arabic chroniclers mention the star-showers of 855 and 856; the shower in the former year was also seen in Europe on the night of October 17. The November star-shower of 1606 is thus described: "On a bright night, November 15, 1606, it seemed as though it rained stars; first fell only the largest and brightest stars from heaven, then indiscriminately the large and small stars in great numbers" [quoted in *American Journal of Science and Arts*, Vol. XXXVI. (2nd Series), p. 301].

It is seen that in these fifteen showers the moon conformed, with but one exception in 1823, to the rule shown to prevail in the more brilliant phenomena; the perigee, on the other hand, does not conform with the same exactness, and, as in the display of 934, the unusual position seems to affect the intensity of these minor meteor-falls. The peculiar position of the moon in all Leonid star-showers cannot be explained as due to moonlight, for the latter would as little diminish the splendour of a meteor display two or three days before as at, or a few days after new moon, and would certainly be far less troublesome a couple of days before full moon, than at or shortly after that phase; yet the moon in any of these great ancient or modern star-showers is never found in the second or fourth quadrants. It is remarkable that at the failure of the Leonids to appear on November 15th, 1899, the moon was within her second quadrant, and in her fourth at the Leonid epoch of November 15-16, 1900. With the moon in the first quadrant, moderately fine displays of Leonids were seen in America on November 15 in the years 1898 and 1901. It is remarkable that the lunar conditions at the Leonid epoch of 1766 resembled those of 1899, and that there is no record of a shower having taken place in the former year. The moon also happened to be unfavourably, or at least unusually, placed for meteor displays at the Leonid epochs of 1899, 1566, and many other occasions when important meteor-showers might have been expected to have occurred.

The conclusion which it seems to me is to be drawn from the foregoing coincidences respecting the position of the moon and the occurrence of Leonid star-showers, is that there is a meteor-swarm revolving round our planet, and that showers of shooting stars are produced from the perturbations of this meteor-ring under the combined action of the sun and moon. The velocity of shooting stars must be much lower than is generally supposed. Mathematicians at first assigned these bodies a velocity of 200 miles per second, a velocity that was subsequently abandoned only when it was found that gravitation failed to account for it. The heavier shooting stars, or bolides, have, however, in well-authenticated instances, been found moving at the rate of about 4 miles per second.

JOHN R. HENRY.

Dublin, September 15th, 1903.

CURIOUS SUNSET PHENOMENON.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I think that the phenomenon described in the September number of KNOWLEDGE by Lieut. Field must be what is commonly called in Canada a "Sun-Dog." We see them frequently in the *winter*, and usually accompanied by cold weather. I have only noticed them when the sun is a few degrees above the horizon; sometimes the sun is obscured, as noted by Lieut. Field, at others the sun is shining brightly and there is merely a slight haze of ice crystals. I think the Sun-Dog is a branch of the phenomena classed under the general term of "halos and parhelia," which are caused by refraction of the sun's rays through floating particles of ice. Just why the halo should take more than one form it is hard to say, though I am inclined to think that the ice crystals, being rhombohedral in form, would have a tendency to make their "refraction products" more complicated than in the case of the simpler raindrop; one can imagine the ice crystals all lying in one direction at one time and in another at some other occasion, or having the sun's rays refracted first through one layer of ice particles and then through a second.

At the elevation of Lieut. Field there would be every chance of there being a screen of ice crystals between him and the sun, although the temperature at the point of observation was a long way above the freezing point. I have often noticed a solar halo in the cirrus clouds when the temperature of the surrounding air was above 32° F. In his case he was looking horizontally through the layer of cold air; in the case of the solar halo I refer to, one is looking upwards.

PAUL A. COBBOLD.

Haileybury, Ontario, Canada,
September 14th, 1903.

THE PURPLE FLOWERS OF THE WILD CARROT.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I find in one of the *Umbelliferæ*, which I believe to be *Daucus*, a single central floret of different colour from the rest. I have to-day seen it pink and dark-red. And in Scotland I was shown some that were dark blue or purple. Is it usual, and does it occur in any other members of the family?

E. A. BURCHARDT.

Brashfield, Bicester,
15th September, 1903.

[The central flower, or several flowers, of *Daucus Carota* is frequently of a deep-red colour—generally, in fact, is a well-developed umbel. No similar feature is found in any other British umbellifer. I am not aware that any explanation of this curious feature has been put

forward. The natural assumption appears to be that it is connected with the "advertising department," that in some way it makes the flower-head more conspicuous to insects, and thus helps cross-fertilization. There are numerous instances of *white* flowers being used for this purpose (*e.g.*, in the Daisy), but I cannot think of an instance where the abnormal flowers are *dark*. —R. LLOYD PRAEGER.]

MAN'S PLACE IN THE UNIVERSE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Will you allow me to express my dissatisfaction with Mr. Maunder's article in your current number upon the above question? Dr. Wallace's position, as to our place in the universe, is, that whatsoever evidence we have goes to support the conclusion that we are placed in or near the centre of the stellar universe; and that the universe itself is limited in extent. For the first point, Dr. Wallace has the support of the following evidence adduced by Sir Norman Lockyer:—"The stars in question in the Milky Way, which is a great circle, are all equally remote; and the only place where such a state of things can be observed must be a point equally distant from all, that is, in the centre of the system under observation. It is worth while to repeat, that because we are in the centre, because the solar system is the centre, that the observed effect arises" (*Nature*, November 8th, 1900).

For the limited dimensions of the universe there is the dynamic principle adduced by Lord Kelvin to show that the velocity of the stars in their drift is only compatible with a universe of limited dimensions. Now it is a very unsatisfactory reply to these things to speak of what *may* be, which, moreover, is a very unscientific position to take.

Maidstone, October 9th, 1903. W. WOODS SMYTH.

[Neither Sir Norman Lockyer's nor Lord Kelvin's arguments in the least support Dr. Wallace's position. Mr. Woods Smyth must remember that the whole object of Dr. Wallace is to prove that our solar system is the *only* one in which intelligent life is possible. He assumed that if he could prove that our sun was in the centre of the universe this would follow. It was a mere assumption, which he has practically withdrawn; but let that pass. Admitting its validity, it was still necessary for him to prove that our sun was much nearer to the centre of the universe than was the case with any other sun whatsoever. Neither of the two authorities quoted help him here.—E. WALTER MAUNDER.]

STELLAR SATELLITES.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Mr. Gore, in his article under above title, in KNOWLEDGE for September, refers to the companion to Procyon. I think Burnham with the 36-inch failed to see this at all from 1888 to 1891 (see *Lick Publications*, page 63). Has it been seen since? If so, by any one except Schaeberle?

Mr. Gore refers also to the double companion to Rigel. I think Burnham afterwards doubted his observation of 1871. At any rate he found it single in 1889–1892 (see *Lick*, page 43).

Mr. Gore refers to what he calls "this rule," that most of the known binaries are of nearly equal brightness. I think the use of such words as "rule" and "law" is often objectionable. They imply more than is intended. But in the case referred to is it not—so far as it is a fact—because unequal binaries are much more difficult to discover and to observe? I don't think there is sufficient evidence that they are less numerous.

In another instance he says there are some stars which do not show orbital motion "which are *known* to be physically connected." In the next sentence he says "they are most *probably* near enough to be linked together by the laws of gravitation." But does not knowledge transcend probability? If they are *known* to be physically connected, are they not more than probably linked together by gravitation?

Mr. Gore also seems to use the word brightness indifferently for quantity of light and surface brilliancy. I know this is a very common practice, but it is a very awkward one.

Mr. Gore's speculations are very interesting, and would be more so if the parallaxes he uses were reliable, but when he calls a parallax of 0″·054 only "somewhat" doubtful he uses a very mild expression about it.

EDWIN HOLMES.

Notices of Books.

"THE POSITION OF THE OLD RED SANDSTONE IN THE GEOLOGICAL SUCCESSION." By A. G. M. Thomson, F.G.S. (Leng & Co.)—This well-printed book has been issued with all seriousness, and with no "controversial intention" (p. 224). The author frankly styles his views "hypotheses," but unfortunately appears to be ignorant of the long discussion which has moulded geological opinion as to the position of the Old Red Sandstone. He is unaware that he might have quoted the illustrious name of Jukes in support of his proposal (p. 97) to regard the Carboniferous and Devonian strata as contemporaneous facies of a single system (see *Quart. Journ. Geol. Soc.*, Vol. xxii., 1866, pp. 367-9). Mr. G. H. Kinahan, boldly carrying out Jukes's suggestions, has, moreover, anticipated Mr. Thomson as regards the intercalation of Old Red Sandstone conglomerates in the Carboniferous system (p. 90). It might have been expected that an author so anxious to improve upon our present knowledge would at least consult our current text-books. Sir A. Geikie, for instance, stated the case clearly ten years ago in his "Text-book of Geology" (3rd edition, p. 778); and the expanded form in which his remarks now appear (4th edition, 1903, pp. 981-2) should prove still more instructive to Mr. Thomson. He will learn from those excellent passages that geologists in general do not regard the Old Red Sandstone as of necessity conterminous with the marine Devonian system; but he will also find that the continental evidence for independent Devonian and Carboniferous systems has long proved fatal to the hypothesis of Jukes. Mr. Thomson, however, with a fine disregard for both stratigraphy and palæontology, considers that the Silurian beds containing fish-remains, and the Devonian and Carboniferous systems, represent varying types of deposit which *began* to be laid down at the same time side by side (pp. 49, 70, etc.). The British Coal-measures are for him a huge drift-deposit, brought in suddenly from some other quarter of the globe. The Atlantic Ocean and the American Continent (p. 36) are held to have existed in the Palæozoic era. The evidence as to the vast extent of post-Carboniferous denudation in our islands (p. 59) is absolutely overlooked. We gather from p. 218 that the variety of fresh-water, brackish-water, and marine deposits recognisable in our coal-bearing strata have never been seriously examined by the author. Mr. Thomson writes modestly throughout, but he has entered the field with a disregard for pioneers which will hardly commend him to the scientific reader.

"RADIUM AND OTHER RADIO-ACTIVE SUBSTANCES: POLONIUM, ACTINIUM, AND THORIUM." By William J. Hammer. (Sampson Low.) 5s. net.—Few discoveries have ever been received with greater interest than that of the radio-active properties of radium and its congeners. In the first place, it appeals to the sense of the marvellous which is present in all of us, and this none the less that old and apparently well-established laws seem to be violated by it. A few milligrams of radium, we are told by Prof. Curie, when introduced beneath the skin of a mouse near the vertebral column, produced death by paralysis in three hours. The introduction of radium into the science of chemistry will produce—who knows what? Already Prof. Armstrong, "speaking as a chemist," can scarcely express his astonishment at the audacious physicists who are opening up a new world to

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us. It has long been the dream of philosophers that matter is composed of some primordial substance, arranged in more or less stable configurations, which we term atoms; but to the chemist the atom must be absolutely indivisible, or where will the fundamental chemical definitions be? Meanwhile, the general public looks on with that kind of interest which may be defined as a lively sense of surprises to come. And truly the surprises come, not as single spies, but in battalions; so quickly, indeed, that a *résumé* of our knowledge, as it was last April, has already taken on an air of commonplace antiquity. Nevertheless, Mr. Hammer's pamphlet on radio-active substances is a welcome contribution to the literature of the subject. In the first place, it traces the "birth and growth and signs" of the new ideas which are leavening our knowledge; and this is a worthy task, for at present the fame of the Curies, well deserved as it is, bids fair to blot out all recollection of the patient toilers who took the first few steps in the new direction. In the second place, it simply bristles with accounts of experiments and facts of importance, and at present we require a good deal of experimental ballast to give us a feeling of stability. Lastly, Mr. Hammer directs attention to some lines of experimental enquiry which are like to be forgotten in the enthusiasm for radio-activity. The first ten pages of Mr. Hammer's pamphlet are devoted to the consideration of fluorescence and phosphorescence. Most of us have seen the glow-worm, and those who have travelled in warmer climates have been charmed by the scintillations of the firefly; yet how many reflect that in these animals Nature has solved the problem of the economical production of light, which up to the present baffles human intelligence? What would be the result if we, like the firefly, could produce light without heat, and therefore at about one four-hundredth of its present cost? Leaving this interesting enquiry unanswered, as it must remain till our knowledge is considerably increased, Mr. Hammer devotes the next thirty-two pages to radio-activity properly so called. Starting with the early experiments of Henry, Niewenglowski, and Becquerel, the development of our knowledge is traced up to the point at which Prof. Curie found that radium produces heat without any apparent chemical change. As to the physical explanation of this phenomenon, the author has nothing to say; indeed, it was not till after the date at which he wrote that the researches of Rutherford and Soddy, Sir William Ramsay, and Sir William and Lady Huggins gave us a clue. At present it appears that radium atoms spontaneously decompose, and produce, amongst other products, the gas helium. To this idea Prof. Armstrong objects that in the whole range of chemical knowledge there is no evidence of atomic disintegration occurring under earthly physical conditions. But what are we to think? Helium certainly appears where there was no previous trace of its existence, and that in a manner altogether incompatible with our accepted ideas of chemical action. In addition, Prof. Dewar finds that radium produces heat freely at the temperature of liquid air, and more freely still at the lower temperature of liquid hydrogen; at such low temperatures there is, in the whole range of our chemical knowledge, no instance of ordinary chemical action. We are, therefore, certainly bound on an excursion into the unknown, and must shape our theories according to our new lights. It is surprising, however, that no one, in an attempt to explain the unknown by the incomprehensible, has so far dragged the "fourth dimension" into the discussion of these results.

Mr. Hammer next devotes about twenty pages to the properties of selenium, and describes many interesting arrangements by which sound may be transmitted "on the wings of light." The action of light on selenium is scarcely less interesting than the radio-activity of radium, and its mode of action is at present scarcely less obscure. Perhaps the two will ultimately be found to be related phenomena.

Mr. Hammer concludes with a short description of the effects of ultra-violet light on various forms of disease. Here, at least, we are tempted to repeat the platitude that there is nothing new under the sun; for a physician of the time of Queen Elizabeth stated that red light was beneficial to patients suffering from small-pox, while sunlight was distinctly harmful. This result has been found, by Prof. Finsen, to be due to the action of ultra-violet light on diseased tissue; while it is in the last degree harmful to small-pox patients, it can be utilized with remarkable success in the cure of lupus and similar diseases. Whether radium emanations may be ultimately used with success in the treatment of consumption and cancer is not yet known; but where so much has already been done we at least have grounds for hope.

"HISTORY OF PHILOSOPHY." By William Turner, S.T.D. (Ginn & Company.) 12s. 6d.—As a text-book for the student of philosophy this volume should prove of real service, but the reader must be on his guard as to the obvious bias of the author. Compiled from the best authorities, this attempt to set forth the succession of schools and systems of philosophy may be commended for its informing order and admirable method. Comprehensive in its scope, it is clearly and lucidly written, while throughout the work the statements of doctrine are accompanied by valuable bibliographical references. And, finally, the book is furnished with an adequate index.

BOOKS RECEIVED.

Retrospect of the Development of American Pharmacy and the American Pharmaceutical Association. By Frederick Hoffmann, PH.D.

Observations of a Naturalist in the Pacific between 1896 and 1899. By H. B. Guppy, M.B., F.R.S.E. Vol. I. (Macmillan.) 15s. net.

Conduction of Electricity through Gases. By J. J. Thomson, D.SC., LL.D., PH.D., F.R.S. (Clay.) 16s.

Introduction to Metallurgical Chemistry. By J. H. Stansbie, B.SC., F.I.C. (Bristol: John Wright & Co.; London: Simpkin, Marshall.) 4s. 6d. net.

Minute Marvels of Nature. By John J. Ward. (Isbister.) 7s. 6d.

Protozoa and Disease. By J. Jackson Clarke, M.B.(LOND.). (Baillière, Tindall & Cox.) 7s. 6d. net.

Drawing. (Self Educator Series). By Robert Y. Howie, M.A. Edited by John, M.A., B.SC. (Hodder & Stoughton.) 2s. 6d.

Flowering Plants. By Charlotte L. Laurie. (Allman.) 2s. 6d.

Photography by Rule. By J. Sterry. (Iliffe.) 1s. net.

Galileo, His Life and Work. By J. J. Fahie. (Murray.) 16s. net.

Short Studies in Economic Subjects. By J. H. Levy. (Personal Rights Asson.) 1s. net.

Theoretical Geometry for Beginners. By C. H. Allcock. (Macmillan.) 1s. 6d.

Cassell's Popular Science. Edited by Alexander S. Galt. (Cassell.) 12s.

The Handyman's Book: Woodworking. Edited by Paul N. Hasluck. (Cassell.) 9s.

Electricity and Magnetism. By R. T. Glazebrook, M.A., F.R.S. (Clay.) 7s. 6d.

Museums Journal. Edited by E. Howarth, F.Z.S. (Dulau.) 12s. net.

Individual Immortality. By E M. Caillard. (Murray.) 3s. 6d. net.

Life and Public Services of Simon Sterne. By John Foord. (Macmillan.) 6s.

Lessons in Physics. By Lothrop D. Higgins, PH B. (Ginn.) 4s. 6d.

Maculay's Life of Samuel Johnson. Edited by C. L. Hanson. (Ginn.)

Practical Orthochromatic Photography. By Arthur Payne, F.C.S. (Iliffe). 1s. net

Journal of the Society of Comparative Legislation. Aug. (Murray.)

The Practical Photographer. Oct. (Hodder & Stoughton.) 1s. net.

Buddhism. Sept. (Rangoon: Hanthawaddy Printing Works.) Rs. 2.

Transactions of the Edinburgh Geological Society. Vol. VIII. (Simpkin.) 6s.

Addresses and Essays. By Ralph Waldo Emerson. (Rational Press Association.) 6d.

Jesus Christ: His Apostles and Disciples in the Twentieth Century. By Count Camille de Renesse. (Rational Press Asson.) 6d.

On the Relationships between the Classes of the Arthropoda. By George H. Carpenter, B.SC.(LOND.), M.R.I.A. (Dublin University Press.)

The Science Student's Note Book, 1903-4. 6d. *The Science Teacher's Pocket Book and Diary, 1903-4.* 1s. (Manchester: James Woolley, Sons & Co., Ld.)

Lenses for Photography. (Taylor, Taylor & Hobson, Ld., Leicester.)

The Scientific Roll. By Alexander Ramsay. (Sharland.) 1s.

The Reliquary and Illustrated Archæologist. Oct. (Bemrose.) 2s. 6d.

BABY BATS.

By R. LYDEKKER.

EVER since the days of Pliny it has been a matter of common knowledge that female bats are in the habit of carrying their helpless young about with them during their aerial flights for some time after birth. With the exception of one peculiar species, to which allusion is made in the sequel, the young bat always clings to the under surface of its mother's body, where it obtains a secure hold among the dense coat of hair. The precise

position in which the young bat supports itself when its parent is in flight does not appear to be recorded; but when in repose, in the case of fruit-bats, or "flying-foxes," at any rate, the baby bat hangs head-downwards on its mother's chest, as is well shown in a figure published some years ago in the *Proceedings* of the Zoological Society and reproduced in the "Royal Natural History."

By the older observers it was generally considered that bats commonly produced two young at a birth, as is testified by Pliny, who wrote that the female carried her twin offspring about with her (*geminos infantes secum deportat*). Later observations, however, led to the conclusion that this idea was erroneous, and that as a rule only one is produced in a birth. For instance, in the second edition of Bell's "British Quadrupeds" it is stated that "the examination not merely of British species, but of a great number of foreign ones, has convinced us that where more than one young one is produced it must be regarded as an exception to the general rule."

In an earlier passage of the same work occurs the following statement: "The female bat brings forth one or two young at a birth, which she nurses with great tenderness and care, carrying it about with her, and holding it enshrouded in her ample cloak, which preserves it from all intrusion." Apart from the question whether the grammar in this quotation is as accurate as it might be, it will be noticed that the author confines himself to the statement that the mother bat carries a single offspring about with her. What becomes of the other, in the case of twins, is not stated.

The late Dr. G. E. Dobson, in his time the greatest authority on bats, noticed that in certain species of fruit-bats the nipples of the males were much enlarged during the breeding season; and from this circumstance he started an entirely novel idea, which is expressed in the following sentences:—

"It is probable that where two young are born at a single birth, the male relieves the female of the charge of one (as the weight of two might render flight difficult or impossible), and at the same time performs the office of a nurse. It is well known that many species of bats have occasionally two young at a birth, but I have never found a mother with more than one clinging to her body. The size of the pectoral teats in many male specimens (though in none yet observed by me so large as in this species and in another case referred to above) led me to think that instances of the male performing the office of nurse are probably not uncommon among bats."

Whether this suggestion is true in the case of fruit-bats must be left for future observation to determine; but it is now practically certain that it will not hold good for the ordinary insectivorous bats, although, so far as I know, no case has hitherto been recorded where a female of any of the European species of bats has been actually seen carrying about her twin offspring. The interest that would attach to a well-authenticated instance of this nature may be commended to the attention of the readers of KNOWLEDGE.

If, however, instances of female bats carrying more than one baby offspring clinging to their bodies are unknown in Europe, they have recently been brought to light in America. And in these instances not only has the parent bat been seen loaded with the weight of twins, but actually with that of a quartette.

Till the date of the aforesaid discovery (to which brief allusion has been previously made in our "Notes" column), it was the universal belief that bats never produced more than two offspring at a birth. In the spring of 1902 the female of a common species of American bat (*Lasiurus borealis*) was, however, received at the British Museum, accompanied by a quartette of young ones, which were stated by the collector to be her own progeny. In mentioning the circumstance, the describer of this specimen (which happened to belong to a new variety) very wisely refrained from giving it full credence until further testimony was forthcoming.

Such evidence was not long in appearing; and it is now definitely known that not only *Lasiurus borealis*, but other species of the same genus, and probably those belonging to the allied *Dasypterus*, are in the habit of generally producing four young ones at a birth. And, what is more, these four young ones are habitually carried about by the female, although no one has apparently yet taken one of these bats thus loaded in actual light. It was in June, 1902, that a female *borealis* was brought to the United States National Museum with her family of four still clinging to her body; and she was successfully photographed shortly before her death, one of these photographs being reproduced in the accompanying illustration.

Bats of the genera *Lasiurus* and *Dasypterus*, it is interesting to notice, differ from the majority of their kind in being provided with four nipples; and in the case of

Female and Young of Rough-tailed Bat.

the female brought to the New York Museum a young bat was tightly holding on to each nipple by its curiously hooked teeth, aiding its grip by including a tuft of its mother's hair. European bats, on the other hand, have but a single pair of nipples, from which it may be inferred that they never produce more than two at a birth. That such twins, when they occur, are, however, carried about by their mother, may be regarded as practically certain.

In the case of the New York specimens, the weight of the female was 11 grams, while the combined weight of the four offspring was 12·7 grams. At the time the young were less than one-third grown, and they would evidently have remained for a further period with their parent. How she could have managed to fly at the date of observation—let alone later on—with a burden exceeding her own weight, is a mystery. And yet there is little doubt that she must have been capable of flight when thus laden, as otherwise she could not possibly have procured food, unless, indeed, supplies were brought her by the male, which is highly improbable.

XUM

This instance, it may be observed, affords a warning against drawing inferences, like the one quoted above, with regard to the powers and habits of animals on wholly insufficient data.

Before dismissing this part of the subject, reference may be made to a peculiarity in the structure of the teeth of baby bats, which appears to be correlated with their abnormal mode of life. It is well known that in the majority of mammals the milk or baby teeth differ somewhat in form from their permanent successors, but the differences are comparatively small, and both series are of the same general type. In bats, on the contrary, the milk-teeth are utterly unlike those of the permanent series; being slender, with sharp, hook-like cusps—in fact, just such a type as would be adapted for obtaining a firm hold of the nipples of their parent while she is in flight. And there is every probability that this is their true function. Possibly, indeed, baby bats may hold on to the maternal nipp'es during the whole time that they are in the air, as was found to be the case with the young of the New York female. It is also significant in this connection that bats shed their milk-teeth at a relatively early age—not improbably at the time when they learn to shift for themselves.

Such, then, are the leading facts in regard to what is known of the nursery arrangements of ordinary bats. There is, however, one very remarkable—and, it may be added, very ugly—bat which has struck out a line altogether of its own in this respect, for a parallel to which we must go to the marsupials. The species in question is the naked bat (*Chiromeles torquata*), of the Malay countries, which is the only representative of a genus whose nearest relatives are the mastiff-bats of tropical America.

In this large and hideous species the thick skin is almost entirely naked, and thrown in the chief regions of movement into a number of deep wrinkles and folds. But its most peculiar feature is the presence on the chest and under the wings of large pouches in which are placed the nipples; these nursing pouches being present in both sexes. These pouches, writes Dr. Dobson, "are probably absolutely necessary for the preservation of the young, which could scarcely otherwise succeed in maintaining its hold on the naked body of the mother during flight. It is interesting to find these pouches developed in both male and female, for their presence in the former suggests the idea that, where two young are born together, the male may relieve the female of the charge of one of them."

So far as I can ascertain, nothing is known with regard to the breeding habits of this bat, and it is consequently quite uncertain whether twins are ever produced. Whether there is any truth in Dr. Dobson's suggestion must therefore, for the present at any rate, remain undecided. It is, however, quite conceivable that the presence of the pouch in the male may not be connected with the nursing function, but may be an acquired secondary sexual character analogous to the presence of horns in the females of many antelopes and the reindeer. So far as it goes, the case of the American *Lasiurus borealis* is against the theory that the males of any species of bat undertake the duties of a foster-mother, since it is clearly demonstrated that the weight of even four young ones is no hindrance to the activity of the female. From the nature of the case it would, however, be a very difficult matter to prove that Dr. Dobson's theory with regard to the naked bat is or is not true. To prove it true, a male must be taken with a young one in its pouch, while to demonstrate that it is false, a female must be captured with a pair of young bats in the same receptacle. And since it is highly likely that the birth of twins is a rare event (even if it ever occurs), the chances of either of these discoveries being made would appear to be extremely remote.

Apart from the question whether or no the male acts as foster-mother, the discovery of a naked bat with young in her pouch would be of extreme interest from another point of view. The young of ordinary bats are born in an advanced state of development, with their eyes open and their bodies covered with hair, as indeed is absolutely essential owing to the nature of their environment and the active muscular powers they have to exert soon after their entry into the world. But the young of the naked bat would seem to have no need either of protection from cold or of active muscular exertion during its sojourn in the nursing-pouch. Is it then born naked, or does it when just formed retain the hairy coat of the ancestral type from which it is descended? Some might even go so far as to suggest that the young of a bat thus specially protected as soon as it enters the world would be born in a helpless condition recalling that of young marsupials; but there are considerations which render this idea improbable.

MICROSCOPY

Conducted by M. I. CROSS.

"SPRING-TAILS."—While examining some duck weed (*lemna*), a number of minute black insects were noticed which continually jumped and sprang in all directions. These turned out to be specimens of *Podura aquatica*, commonly called "Spring-tails," a low type of insect life, in which the mouth parts have degenerated, a *collophore*, or sucker, has developed on the ventral side of the abdomen, and the caudal spines present in some nearly related species have been modified into an apparatus placed under the abdomen, which jerks the insect suddenly and sharply into the air. *Podura aquatica* is very small, $\frac{1}{21}$ of an inch long, and several can be kept alive in a cell and examined from time to time under the microscope. This is most interesting, as their movements are slow, except when the spring comes into action, and their appearance grotesque and quaint. Sometimes they crawl on the surface of the cover-glass, and this gives an opportunity to examine the ventral side, and the spring and sucker. Both sides of the body are shown in the

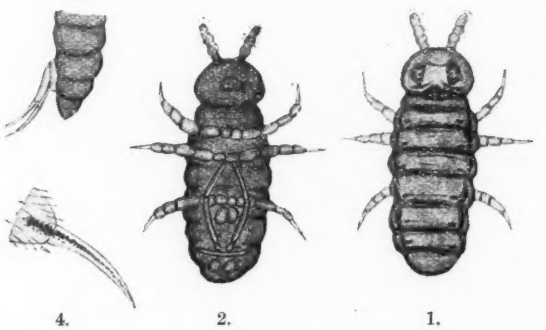


FIG. 1.—"Spring-tail," *Podura aquatica*, dorsal view. FIG. 2.—Ventral view of *P. aquatica*, showing the mouth, the *collophore*, and the "spring" in its normal position. FIG. 3.—Lateral view of the posterior end of the insect, showing the position of the spring on being released. FIG. 4.—One of the claws, showing the gland and perforation.

illustrations, as well as a side view, showing the appearance of the spring after it has been released. The sucker is supposed to be used in resting, attaching the insect to an object; it is so rare in entomology, that those families possessing it, are grouped in the sub-order Collembola. The claws are also provided with a gland containing a viscid secretion, which runs down a minute perforation, and enables the "spring-tail" to adhere and walk on glass head downwards. After I had kept the insects about ten days several of them cast their skins. They are said to eat them, but mine did not. The cell alluded to can be made thus: Take a piece of thin wood or stout cardboard, two inches long by one broad. Out of one of the ends, punch or cut a hole, about half an inch from side to side. Cut several pieces of blotting paper the same size as a glass slip (three inches by one inch). Pink blotting paper must be used, as white is bleached by a chemical injurious to insects. Wet the blotting paper, place it on the glass slip; on this place the wood or cardboard in such a manner that the hole or cell is in the centre of the slip. After having placed the insects with some weed in the cell, cover the opening with a square piece of cover-glass. Keep the whole bound together with two elastic bands, or tie with thread. This cell, if the blotting paper is daily wetted, will keep the insects alive for a considerable time. The slip can be kept under a bell-glass to prevent evaporation.—W. WESCHÉ, F.R.M.S.

DETERMINING THE NUMERICAL APERTURE OF DRY OBJECTIVES.—Several suggestions have been made for rendering easy the exact determination of the N.A. of objectives, but the method attributed to Mr. Conrady, which appears in "Photo-micrography," by E. J. Spitta, is probably one of the simplest.

Briefly, the system recommended is as follows:—Two pieces of white paper are laid upon a black background, their straight inner edges set parallel to one another at a convenient distance apart, say 20 cm. for lenses of ·5 N.A. and over, but less for low angled ones.

A scale, or some accurate means of measuring, is held vertically about mid-way between the two pieces of paper, and the objective to be tested placed vertically against the edge of the scale. It will now be noticed on examination of the back lens—the eye being placed at a distance about equal to the tube length, for which the objective is designed—that as the objective approaches the table the interval between the images of the two pieces of paper will widen until at last a point is reached where only a slight bluish flicker remains visible on either side at the extreme margin of the lens.

This is an indication that the inner edges of the pieces of paper are in the path of the most oblique rays that the objective is capable of receiving, and the angle between these two points, taken at the principal focus of the objective, is the angle of aperture.

This is now determined by reading off the vertical distance from the table to the front of the objective in this position and then subtracting the working distance of the lens so as to get the distance from table to focus.

This distance divided by half the distance between the two pieces of paper is the co-tangent of the semi-angle of aperture. The latter may be then obtained from a table of trigonometrical ratios, and the sine of the same angle is the N.A. of the objective.

This method has proved wonderfully accurate and rapid, and, without adding to the labour involved, an improvement may be effected by using the microscope for holding the objective and determining the various vanishing points by the rackwork.

It will then be a very easy matter to measure the distance between the sheets of white paper, which can be conveniently laid on a piece of black cardboard on the stage of the microscope in front of the objective.

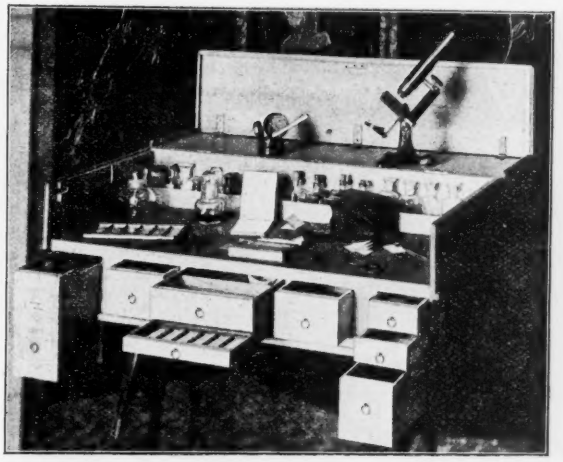
It also facilitates the measurement of the working distance of the lens. Of course no eyepiece would be used.

This system is applicable to dry lenses only.

MICROSCOPE TABLE.—In the number of this journal for November, 1902, some suggestions were made and devices invited for a microscope table, suitable for work in a restricted space, and in the January number a correspondent sent details of one that he was using.

We have since received further suggestions, but the best emanates from Mr. B. H. Morgan, and will be appreciated by reference to the illustrations herewith, one showing the table open and the other closed.

The table top measures 2 ft. 8 in. by 1 ft. 3 in., and with the top in position an extra shelf is available, 2 ft. 8 in. by 10 in.



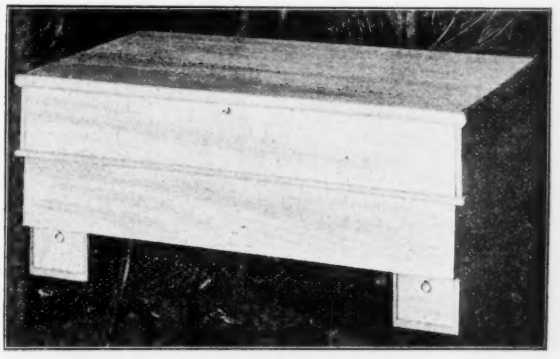
Microscope Table.

This top rests on two brass tubes which push out from the sides.

The eight drawers vary in size, the largest will take 10 oz. bottles, and the smallest 3 in. by 1 in. slips.

The front is removed when in use, and when in position it is held by two dowels, and one lock secures the whole. Such a table could be mounted on a sewing machine stand, or on proper bench legs.

The advantages of such a table will at once be obvious, every-



Microscope Table.

thing can be closed and left in position at a moment's notice, and dust is excluded.

PHOTOGRAPHING IMAGES IN THE CORNEA OF A BEETLE'S EYE.—There are probably few objects which create so much interest as the exhibition of multiple images in the cornea of a beetle's eye, and correspondents constantly write to inquire how the effect is produced.

I have previously indicated the method in these columns, and now in response to further requests, describe the manner of photographing those multiple images.

The following is a simple process:—The subject that is to appear in the facets of the cornea has to be made transparent, in other words a reduced negative has to be taken, and a transparent positive copied from it. A convenient size for this will be $\frac{1}{4}$ in.—$\frac{3}{8}$ in.

This may now be placed in the stop-holder of any condenser mount with, preferably, the condenser removed. All light should be blocked out around the transparency.

Either $\frac{1}{2}$ in. or $\frac{1}{4}$ in. objectives may be used, and the instrument should be fitted to the photo-micro camera in the ordinary

way. It will be necessary to have in addition to the source of illumination a bull's-eye condenser.

Remembering that the images do not come into view in the same focal plane as the cornea itself, but in a higher one, the same as when viewing the images, the subject is focussed on the ground-glass screen of the camera, and the negative taken. Heads and busts of people seem to form the most suitable and popular objects with which to experiment.

PRACTICAL SCHEME.—Through the kindness of Mr. A. H. Williams, of Hythe, we are able to offer a quantity of zoophyte material for distribution. Any readers desiring to avail themselves of this are invited to send a stamped addressed envelope, together with the coupon which will be found in the advertisement pages.

NOTES AND QUERIES.

A. Megson.—I am not quite sure from your letter whether you require a book on biology or on natural history; but if it is to have special reference to the numerous subjects which are available for microscopical examination, you cannot do better than procure "The Microscope and its Revelations," by Carpenter, edited by Dr. Dallinger, and published by Churchill. For Protozoa only you would probably find the work entitled "The Foraminifera: An Introduction to the Study of Protozoa," by F. Chapman, very helpful.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

BORRELLY'S COMET (1903 c).—This comet is now visible only in the southern hemisphere as an exceedingly faint object. Some interesting reports of observations are given in *Popular Astronomy*. Mr. C. D. Perrine at the Lick Observatory writes that, with the Crossley reflector, a spectrum was obtained with a small slit-spectrograph on July 15, with an exposure of four hours. Five bands were shown similar to those photographed by Campbell in Rordame's comet of 1893, and Gale's comet of 1894. The brighter of the bands show evidence of composite character, although they are not resolved. Very little continuous spectrum is exhibited. Mr. H. D. Curtis observed the spectrum with the 36-inch refractor on July 14 and 15, and says that visually it showed a relatively strong continuous spectrum and three characteristic bands. Of these, that at λ 4700 seemed brightest. An attempt was made to photograph the spectrum, but the intrinsic brightness of the comet was too small. The comet itself was photographed on several occasions, and two tails appear on all the plates except the last (July 14). On June 30 the primary straight tail extended over 5 degrees, while the secondary curved tail had a length of 1½ degrees. On July 14 there was one straight narrow tail 8½ degrees long.

From observations of the same comet made by M. Deslandres at the Meudon Observatory, and reported in the *Comptes Rendus*, it appears that the spectrum was found of the characteristic hydrocarbon type, but in the region of the nucleus some additional bands were faintly exhibited. M. Deslandres thinks that the temperature of the comet is sufficiently high to bring about incandescence, and concludes that the spectrographic method is capable of increasing our knowledge of cometary physics by defining the structural motions of comets.

BROOKS'S COMET (1889 V.—1896 VI.).—Too faint to be observed in small telescopes, this periodical comet is now situated in the eastern region of Capricornus, near ϵ, and moving very slowly eastwards in a direction away from the earth, though its perihelion passage will not occur until December 11.

GIACOBINI'S COMET (1896 V.).—Astronomers have been sweeping for this object, but apparently without success. It passed its perihelion in June. On October 28 its position is R.A. 3h. 55m, Dec. + 8° 7′, or about 10 degrees S.W. of the Hyades in Taurus, and the motion is extremely slow to S.W.

METEORIC SHOWERS IN SEPTEMBER.—Not many meteors were observed in September this year, but the month is usually a productive one both of fireballs and ordinary shooting stars. In the morning hours at this period, swift, streaking meteors are sometimes very numerous, and their discursive flights afford evidence of an abundance of radiants distributed over the eastern quarter of the heavens. As a means of reference during future observations the following list has been compiled of the positions of the principal showers. These include the swifter class of meteors only; there are a considerable number of streams of slow meteors visible at the same season, but these are chiefly placed in the southern sky, and generally best observed in the evening hours:—

RADIANTS OF SWIFT, STREAKING METEORS, SEPTEMBER 10–27.

°		°	°		°	°		°
48	+	44	77	+	32	105	+	59
55	+	71	78	+	57	107	+	12
56	−	12	80	+	24	111	+	24
57	+	9	86	+	34	115	+	83
60	+	49	87	+	42	118	+	31
61	+	36	87	+	57	123	+	62
63½	+	22½	88	+	19	127	+	58
71	+	3	98	+	43	130	+	46
74	+	42	100	+	13	134	+	37
75	+	15	105	+	51	156	+	41

The most active of these appears to be the one at 61° + 36°, near ε Persei.

THE LEONIDS.—There will be little appreciable interference from moonlight in 1903, and the shower should be carefully looked for on the mornings of November 14 to 17. The conditions scarcely justify the anticipation of a plentiful display, but it may be confidently stated that the Leonids will return, if not in rich numbers, at least in sufficient strength to form a definite shower and to enable their point of radiation to be redetermined. That the stream is one of annual occurrence, like the August Perseids, is certain, though there is a marked distinction between the two, the Leonids being very thickly clustered near the parent comet and scantily dispersed over other sections of the ellipse, whereas the Perseids form a pretty rich and evenly strewn orbit capable of yielding a moderately strong shower every year.

LARGE METEORS.—Mr. A. C. Sykes, while at Wadbury, near Frome, Somerset, on September 12, 9h. 23m., saw a meteor brighter than Jupiter pass from a considerable distance above that planet to above and beyond Altair, the direction being from Andromeda. It descended at an angle of about 15° and left a luminous streak for 3 seconds. Probably the meteor was one of the ϵ Perseids. On September 23, at 12h. 30m., the writer, at Bristol, recorded a bright flashing meteor, which must have exceeded Venus, with a path from 78° + 58° to 127° + 77°, and a radiant at 63° + 23°. Its uneven streak remained visible about 15 seconds. It is to be hoped that this fine specimen of the September Taurids has been observed at other stations. The particular shower from near ϵ Tauri to which it belonged is a tolerably active one during the third week in September. On October 3 two meteors rather brighter than Sirius were observed at Cardiff at 10h. 5m. and 10h. 12m. respectively. The first moved from Perseus towards the Pleiades, and vanished about 3 degrees west of that cluster. The second travelled more slowly, and pursued a longer course, from Polaris to Capella. On October 13, at 9h. 20m. G.M.T., Mr. W. H. S. Monck, of Dublin, saw a meteor equalling Jupiter in apparent brightness. It passed slowly from a little below the double star-cluster in Perseus to between Capella and Ursa Major, and finally disappeared in that part of the Lynx bordering Ursa Major.

DETONATING FIREBALL.—On Saturday afternoon, October 3, a large aerolite is reported to have fallen near Tain, in the north of Scotland. It appeared as a ball of fire, which burst immediately over the town, and gave a thunder-like report audible over a wide extent of the surrounding country. Doors and windows rattled in the villages of Eastern Ross, and the inhabitants were greatly alarmed. A telegram from Rogart, Sutherland, reports a shock of earthquake as having occurred at the same time, but this was certainly due to the detonation and vibration of the fireball.

THE FACE OF THE SKY FOR NOVEMBER.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 6.53 and sets at 4.34; on the 30th he rises at 7.42 and sets at 3.54.

The solar disc is now rarely free from spots and faculæ; at the time of writing there is a spot-group of considerable size visible.

THE MOON:—

		Phases.	H. M.
Nov.	5	○ Full Moon	5 28 A.M.
,,	12	☽ Last Quarter	2 46 A.M.
,,	19	● New Moon	5 10 A.M.
,,	27	☾ First Quarter	5 37 A.M.

The moon is in perigee on the 10th, and in apogee on the 25th.

The more interesting occultations visible at convenient hours are as follow:—

Date.	Star Name.	Magnitude.	Disappearance.			Reappearance.			Moon's Age.
			Mean Time.	Angle from N. Point.	Angle from Vertex.	Mean Time.	Angle from N. Point.	Angle from Vertex.	
			h. m.	°	°	h. m.	°	°	d. h.
Nov. 1	B.A.C. 8094	5·6	0 30 A.M.	77	43	1 34 A.M.	241	204	11 9
,, 4	ξ Arietis	5·5	6 36 P.M.	116	155	7 19 P.M.	205	243	15 3
,, 7	111 Tauri	5·2	11 10 P.M.	140	176	11 47 P.M.	205	238	18 7
,, 9	λ Geminorum	3·6	8 43 P.M.	62	98	9 28 P.M.	301	340	20 5
,, 29	44 Piscium	6·0	8 0 P.M.	81	79	9 16 P.M.	229	212	10 15

THE PLANETS.—Mercury is in superior conjunction with the sun on the 21st, and throughout the month the planet is not suitably placed for observation, being lost in the sun's rays.

Venus is a bright and conspicuous object in the morning sky for some considerable time before sunrise, and throughout the month she rises rather more than four hours in advance of the sun. She attains her greatest westerly elongation of 46° 44′ on the 28th. With slight optical aid, she can easily be seen during the day, and as some guide to her position the following table gives the time she is on the meridian, and the altitude she attains:—

Day.	Time on Meridian.	Altitude.
1	9 A.M.	40°
10	8.52 A.M.	$38\frac{1}{3}$°
20	8.47 A.M.	35°
30	8.46 A.M.	$32\frac{1}{2}$°

The phase of the disc is nearly "half," answering to that of the moon about six days old; about the middle of the month the diameter of the disc is 30″.

Mars is not in a suitable position for observation, being low down in the S.W. shortly after sunset.

Jupiter is favourably placed for observation throughout the month; at the beginning of the month he souths at 8.20 P.M., and at the end at 6.30 P.M. In consequence of his increasing distance from the earth his apparent polar diameter has diminished to about 41″ with a corresponding decrease in lustre. The planet ends his retrograde motion in Aquarius on the 10th when he is at the stationary point; after this date his motion is again direct or easterly.

The configurations of the satellites as seen in an inverting telescope at 8 P.M. are as follow:—

Day.	West.	East.	Day.	West.	East.
1	4 2 1 ○ 3		16	2 ⊙ 1 3	
2	4 2 1 ○ 3		17	4 ○ 3 2 ●	
3	4 3 ○ 1 2		18	4 3 1 ○ 2	
4	4 3 1 ⊙		19	4 3 2 ○ 1	
5	4 3 2 ○ 1		20	4 3 1 ○ ●	
6	4 3 1 ○ 2		21	4 ○ 1 2 ●	
7	4 ○ 1 3 2		22	4 1 2 ○ 3	
8	2 1 ○ 3 ●		23	4 2 ○ 1 3	
9	2 ⊙ 3 4		24	4 1 ○ 3 2	
10	⊙ 2 4 ●		25	3 1 ○ 2 4	
11	3 1 ○ 2 4		26	3 2 ○ 1 4	
12	3 2 ○ 1 4		27	3 1 2 ○ 4	
13	3 1 ○ 4 ●		28	○ 1 2 4 ●	
14	○ 3 1 2 4		29	1 2 ○ 3 4	
15	2 1 ○ 4 3		30	2 ○ 1 3 4	

The circle (○) represents Jupiter; ⊙ signifies that the satellite is on the disc; ● signifies that the satellite is behind the disc, or in the shadow. The numbers are the numbers of the satellites.

Saturn is on the meridian shortly after sunset; about this time, therefore, is the best for observation, as he is low down and sets about 9 P.M. The distance of the planet from the earth is increasing, hence his brightness is diminishing. The diameter of the ball is 15″, whilst the diameters of the outer major and minor axes are 38″ and 13″ respectively; we are looking down on the northern surface of the ring at an angle of 20°, consequently the ring appears well open.

Uranus is approaching conjunction with the sun and cannot be observed.

Neptune rises about 7 P.M., near the middle of the month; he is not far from the star μ Geminorum, as shown on the chart given in the January number.

THE STARS.—About 9 P.M., at the middle of the month, the following constellations may be observed:—

ZENITH . Cassiopeia.

SOUTH . Andromeda, Pisces, Cetus; Pegasus, Aquarius towards S.W.

WEST . Aquila, Cygnus, Lyra a little north of west, Corona N.W., setting.

EAST . Auriga, Perseus, Pleiades, Taurus; Aries to the S.E.; Orion rising S.E.

NORTH . Ursa Major, Ursa Minor, Cepheus; Draco a little west of north.

Minima of Algol will occur on the 7th at 11.23 P.M., 10th at 8.12 P.M., 13th at 5.1 P.M., 28th at 1.6 A.M., and 30th at 9.55 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of October Problems (P. H. Williams).

No. 1.

Author's Key.—1. Q to Q5.

[There is a second solution by 1. Q × Kt.]

No. 2.

Key-move.—1. Kt to Q7.

If 1. . . . K to Q4, 2. Q to Q B5ch.
1. . . . B to B5, 2. Q to B3ch.
1. . . . Other moves, 2. Q to B3ch, etc.

SOLUTIONS received from "Alpha," 2, 4; W. Nash, 2, 4; G. A. Forde (Major), 2, 4; "Looker-on," 3, 4; W. H. S. M., 3, 4; G. W. Middleton, 3, 4; "Quidam," 3, 4; J. W. Dixon, 3, 4; C. Johnston, 3, 4; H. S. Brandreth, 2, 4; H. F. Culmer, 2, 4; T. Dale, 2, 4; E. M. Oakley, 2, 4; E. A. Servante, 3, 4.

Mr. Williams' two-mover has been the cause of Mr. W. Nash dropping a point behind the other three leaders. As we can hardly expect a two-move problem to perform the service of separation again this year, two three-move problems are given this month, and the same device will probably be tried next month.

R. J. Bland.—Thanks for the game and problem. The former appears below, and I shall hope to find room for the latter during the winter.

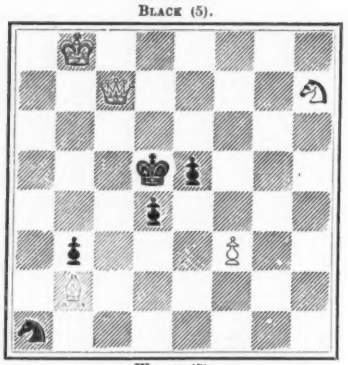
XUM

PROBLEMS.

By J. W. Abbott.

No. 1.

BLACK (5).

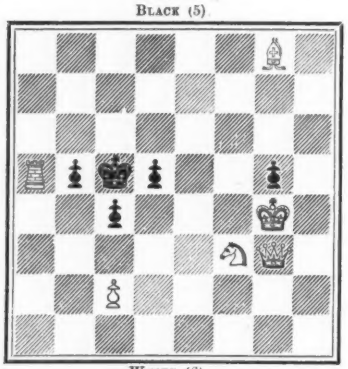


WHITE (5).

White mates in three moves.

No. 2.

BLACK (5)



WHITE (6)

White mates in three moves.

The following game was recently played by correspondence in India.

"Petroff's Defence."

WHITE. (R. J. Bland, Hyderabad.)	BLACK. (R. J, Bangalore.)
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to KB3
3. Kt to QB3	3. P to Q3 ?
4. P to Q4	4. P × P
5. Kt × P	5. B to K2
6. B to K2 (*a*)	6. B to Q2
7. P to KB4	7. Kt to B3
8. P to B5 (*b*)	8. Kt × Kt ?
9. Q × Kt	9. P to B4 ?
10. Q to Q3	10. B to B3
11. B to B3 (*c*)	11. Kt to Q2
12. B to B4	12. Kt to Kt3 (*d*)
13. Castles Q's side	13. Kt to Bsq
14. Kt to Kt5 !	14. P to QR3 (*e*)
15. Kt × P (ch)	15. Kt × Kt
16. B × Kt	16. Q to Q2
17. P to K5	17. R to Qsq (*f*)
18. Q to QB3 (*g*)	18. KB to Kt4 (ch) (*h*)
19. K to Ktsq	19. Q × P
20. B × B (ch)	20. P × B
21. Q × P	21. P to B3 (*i*)
22. P to KKt4 (*j*)	22. Q to K3
23. P × P	23. B to K6
24. P × P	24. Resigns. (*k*)

NOTES.

(*a*) Not 6. B to QB4, on account of the reply 6. . . Kt × P.

(*b*) On principle this should not be good, as it enables Black to establish a Knight at K4, besides leaving the White KP weak. Instead, 8. B to K3 would be a useful developing move. Black's reply is bad, and his next move, weakening the QP, still worse.

(*c*) To prevent P to Q4.

(*d*) Kt to K4 seems the obvious move here. The retrograde movements of the Knight result in a very cramped game, and the immediate loss of a Pawn.

(*e*) Black would equally lose a Pawn after 14. . . B × Kt, 15. Q × Bch, Q to Q2, 16. Q × Qch, K × Q. 17. P to K5, etc. But Castling would be better than the wasted move with the RP.

(*f*) He might as well get Castled on the Queen's side, and so leave the other Rook free. In addition he should exchange the distant Bishops

(*g*) The beginning of a good final combination, in which, however, as at many other stages, he is considerably aided by his opponent's weak play.

(*h*) After this he can no longer Castle. He should still exchange the other Bishops.

(*i*) He cannot well retire the Queen, on account of the threatened advance of the KP.

(*j*) Good enough, but perhaps KR to Bsq. is even stronger.

(*k*) For if 24. . . KR to Ktsq., 25. Q to R5ch, K to Q2, 26. B to B8 dis.ch. wins easily.

CHESS INTELLIGENCE.

The proposed match between Dr. Lasker and Mr. F. J. Marshall having fallen through, as might have been expected, the latter has found an opponent in Mr. Blackburne, who will play a match with him shortly. It is understood that Mr. F. J. Lee is also willing to encounter the American expert.

The Hastings Chess Club Team of ten players has recently concluded a very successful tour among the principal cities of Germany. Out of six matches played three were won, two lost, and one drawn. The one decisive defeat (at the hands of the Berlin Chess Association) was the result of a match not originally on the programme of the tour.

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